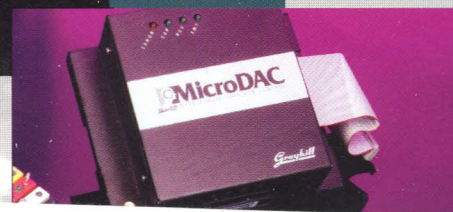
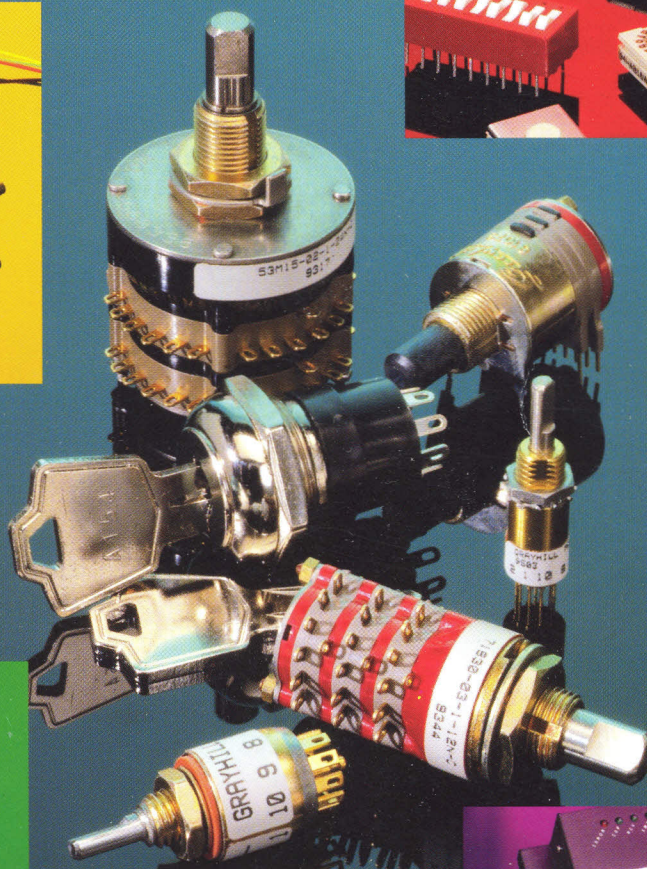
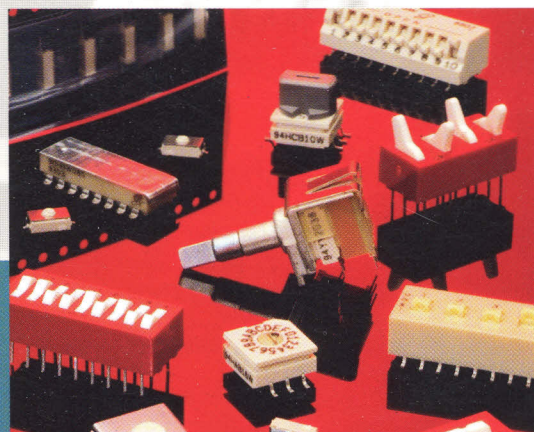


Grayhill INC.

An ISO-9001 Company

Product Catalog



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Lannie Reynolds
Account Manager - W.T.I.

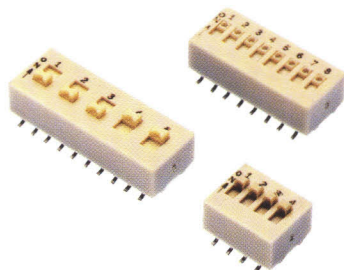
Manufacturers Representatives



7370 Bramalea Road, Unit 6 & 7, Mississauga, Ontario L5S 1N6
Tel.: (905) 673-0011 • Fax: (905) 673-1270
torsales@jgweiss.com

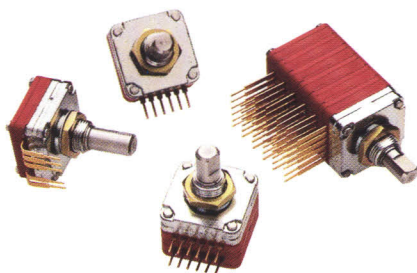
SERIES 78H

High Temperature Surface Mount DIP Switch
page B-8



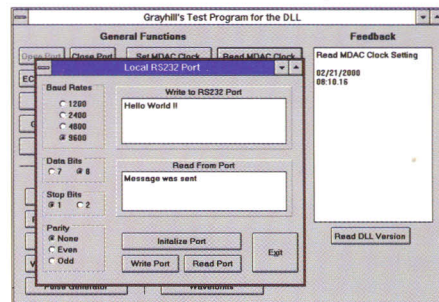
SERIES 25

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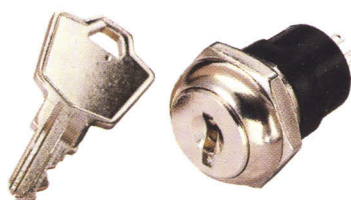
SERIES 94R

Economical Coded Output Rotary DIP Switch
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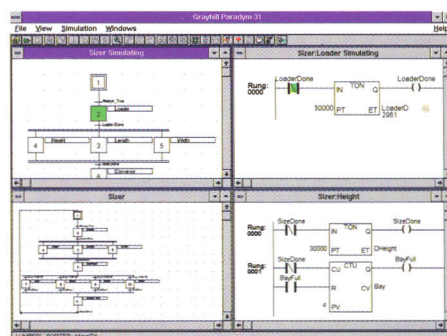
SERIES 03

Low Cost Security Keylock Switches
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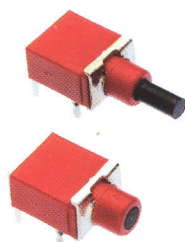
PARADYM-31 SOFTWARE

For Programming MicroDAC
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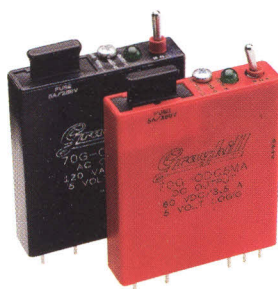
SERIES 38

Miniature PC Mount Pushbutton Switches
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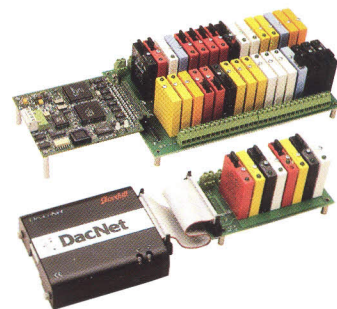
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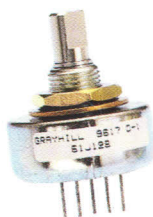
DACNET

DeviceNet Controller
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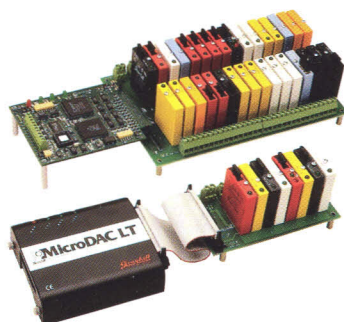
SERIES 61J

5 Pin Optical Encoder
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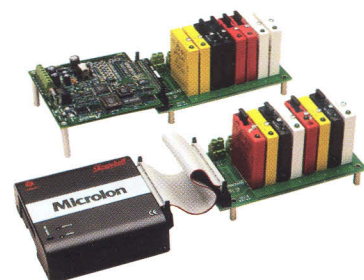
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Company Profile

Grayhill Inc. was founded in 1943 with the commitment to be the industry leader in product quality and customer service in the marketplaces we serve. The many switches, keyboards, and control products you will find in this catalog are still designed, built, tested, and delivered with these goals in mind.

Our headquarters in LaGrange, Illinois, is home to Sales, Engineering, Material Control, and Administrative groups. It is also where our Control Products and many of our switches are built. Additional manufacturing facilities are located in Carpentersville and Fox River Grove, Illinois, and Iola, Wisconsin. We employ approximately 615 people worldwide.

ISO 9001 Certification

The ISO 9000 series is a family of five individual, but related, international standards on quality assurance management systems. They were written over a seven year period by representatives from the 91 countries that are members of the International Organization for Standardization (ISO). ISO 9001 is the most comprehensive of the standards and therefore, the toughest certification level. It not only covers the quality control systems used on the manufacturing floor, but also sets guidelines for management involvement, design control, review of customer requirements, supplier monitoring, and personnel training. To meet the requirements of the specification, our documented systems in each area had to be reviewed and audited by an independent third party assessor.

In March, 1992, the audit was complete and Grayhill became the first U.S. based switch, keyboard, solid state relay, and I/O module manufacturer to earn ISO 9001 certification. At that time, we joined an elite group of approximately 125 other certified U.S. companies. Our certification was granted by Bureau Veritas Quality International (BVQI certificate number 1363). The certification covers our facilities in LaGrange, Fox River Grove, and Carpentersville.

We believe certification is a major benefit for our organization and our customers. It marks a major milestone in our long standing commitment to continuous improvement and serves to reaffirm our reputation as a producer of quality products. We hope our customers recognize this and experience it on every shipment and phone call.



EN 29001/ISO 9001/BS 5750
APPROVED BY BVQI LTD

The QTIOE Process

Our QTIOE process refers to our never ending effort to achieve higher Quality and increase Throughput while requiring less Inventory and lowering Operation Expenses. It is through this process, that we continuously monitor our performance and challenge ourselves to improve. Inherent in the process is the involvement of all Grayhill personnel at all levels. The goal of QTIOE is to attain total customer satisfaction and ensure our long term viability as a supplier.



Customized Products

We understand that the answers to today's complex application problems can't always be found in a catalog. That's why our years of experience in designing and building custom switches for specialized needs has become such an important part of our service. If you have a unique application, let us help. We're ready to work with you to solve your problem quickly and effectively. Remember, no request is too strange (See our section on Value Added Services, pages A-5 through A-6).

We also understand the need to prove your designs. A sample of any item, stock or custom designed, will be provided to you for your prototypes. Inexpensive catalog items are sampled free of charge. A modest charge is applied to more expensive items and those designs requiring extensive engineering.



Local Service

Grayhill's broad range of products are available locally through one of our hundreds of distributors worldwide (See our distributor listing on pages A-7 through A-14). To help with your special application problems, a local Sales Engineer is available to suggest the best solution (See our Sales Offices listing on pages A-7 through A-14). Here at the factory, support staffs are anxious to demonstrate "the Grayhill difference" in customer service and customer satisfaction.

EMI/RFI shielding, connectors, and special mounting configurations to meet all your demands. Early design involvement and rapid prototyping is part of our pledge for total customer satisfaction. The majority of our switches are military qualified and all go through a rigorous in-house testing and qualification process. This, coupled with our in-house molding and tooling capability, guarantees the highest quality switch assembly at all levels.

All special requests will be considered, reviewed, and responded to promptly.

Grayhill has the talent and expertise to provide you with high quality solutions at affordable prices. We will work with your production team at all stages to design a switch assembly or special configuration that meets your individual requirements.

For more information on our value added capabilities, please contact Grayhill at (708) 354-1040 or on-line at <http://www.grayhill.com>.



COMMERCIAL KEYBOARDS

CUSTOM FEATURES

- Snap Dome or Conductive Rubber
- Low Profile Key pads
- Custom Graphics, Legends and Embossing
- Custom Housing and Buttons
- EMI/RFI Shielding
- Special Circuitry
- Custom Terminations
- Special Mountings
- Integrated Electronic Assemblies: LED's, Displays
- Keyboards with Assembled Decoder Electronics
- Custom Illumination
- Backlighting

For standard keyboards, see pages C-1 to C-46

Grayhill has the ability required to accurately assemble thru-hole and surface mount components. Our on-line SPC system ensures a properly manufactured assembly.



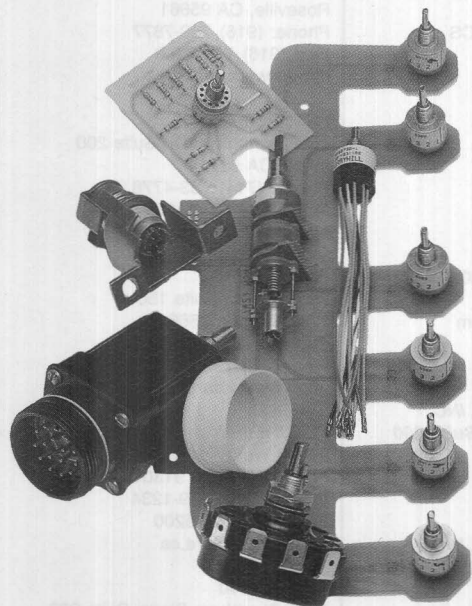
MILITARY KEYBOARDS

CUSTOM FEATURES

- Snap Dome Technology
- Custom Illumination
- Custom Bezels
- In-House Machining Capabilities
- Unique Electronic Configurations
- NVG Compatible Backlighting
- Sealed and Submersible
- EMI/RFI Shielded Windows

For standard keyboards, see pages C-1 to C-46

MIL Specs such as:
MIL-STD-105, 202,
285, 810, 1285,
45662, 595, 454



SOME OF OUR VALUE ADDED FEATURES FOR ROTARY SWITCHES INCLUDE:

- Wire Harnesses
- Flex Circuit Assemblies
- Unique Multi-Deck Configurations
- Integrated Pushbuttons
- Various Mounting Styles & Terminations
- Custom Shafts
- Bracket Mounting Assemblies
- Multiple Component Assemblies

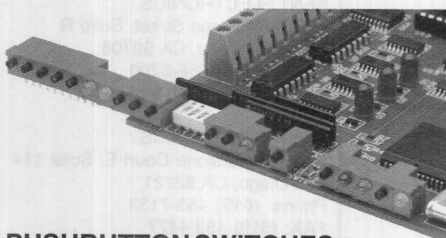
For standard rotaries, see pages F-1 to F-84

OPTICAL ENCODERS

FEATURES

- Custom Terminations
- Flex Cables
- Various Connector Assemblies
- Strain Relief Systems
- Wiring Harnesses
- Custom Shafts
- Electronic Integration
- i.e. Intelligent Encoders

For optical encoders, see pages E-1 to E-22



PUSHBUTTON SWITCHES

Series 32—see page D-9

SALES OFFICES & DISTRIBUTORS

Sales Offices Are Shown in **Boldface Italic Type** All other listings are Distributors

United States Electronic Distributors and Sales Offices

These distributors carry all
Grayhill products.

ALABAMA

Sales Office:
REP, INC.

11535 Gilleland Road
Huntsville, AL 35803
Phone: (205) 881-9270
Fax: (205) 882-6692

FUTURE ELECTRONICS
4825 University Square, Suite 12
Huntsville, AL 35816
Phone: (205) 830-2322
Fax: (205) 830-6664
<http://www.future.ca>

FUTURE/FAI
4825 University Square, Suite 12
Huntsville, AL 35816
Phone: (205) 837-9209
Fax: (205) 837-2723
<http://www.future.ca>

HAMMOND ELECTRONICS
1555 the Boardwalk, Suite 2
Huntsville, AL 35816
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Fax: (205) 830-4287
<http://www.hammondelec.com>

KENT ELECTRONICS
4900-D Corporate Drive
Huntsville, AL 35805
Phone: (205) 837-4000
Fax: (205) 837-6977

NEWARK ELECTRONICS
Toll Free: 1-800-367-3573

TIME ELECTRONICS
4960 Corporate Drive
Huntsville, AL 35805
Phone: (205) 721-1134
Fax: (205) 721-0862
<http://www.time.avnet.com>

ALASKA
Sales Office: See Washington

ARIZONA
Sales Office:
MERCURY ENGRG. SALES, INC.
5050 North 8th Place #8
Phoenix, AZ 85014
Phone: (602) 265-0344
Fax: (602) 265-0398

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2121 West University Drive #112-8
Tempe, AZ 85281
Phone: (602) 731-7204
Fax: (602) 921-8478

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4636 E University Ave, Suite 245
Phoenix, AZ 85034
Phone: (602) 968-7140
Fax: (602) 968-0334
<http://www.future.ca>

FUTURE/FAI
4636 E University Ave, Suite 285
Phoenix, AZ 85034
Phone: (602) 731-4661
Fax: (602) 731-9866
<http://www.future.ca>

KENT ELECTRONICS
15455 North Greenway-Hayden Loop
Scottsdale, AZ 85260
Phone: (602) 998-0399
Fax: (602) 998-0302

LCOMP INC.
206 West Julie Drive #2
Tempe, AZ 85283
Phone: (602) 730-1633
Fax: (602) 831-8757

NEWARK ELECTRONICS
Toll Free: 1-800-367-3573

**PIONEER-STANDARD
ELECTRONICS**
1438 W. Broadway Road, #140
Tempe, AZ 85281
Phone: (602) 350-9335
Fax: (602) 350-9376
<http://www.pios.com>

RICHEY ELECTRONICS
1438 West Broadway Road, #260
Tempe, AZ 85282
Phone: (602) 966-2256
Fax: (602) 921-3351
<http://www.richeyelec.com>

STERLING ELECTRONICS
3312 East Broadway Road
Phoenix, AZ 85040
Phone: (602) 437-5565
Fax: (602) 437-5588
<http://www.sterlink.com>

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1301 West Geneva Drive
Tempe, AZ 85282
Phone: (602) 731-6752
Fax: (602) 968-3854
<http://www.time.avnet.com>

ARKANSAS
Sales Office: See Texas

CARLTON-BATES COMPANY
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Little Rock, AR 72219
Phone: (501) 562-9100
Fax: (501) 562-4931

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Toll Free: 1-800-367-3573

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QUADREP, INC.
2635 North First Street, Suite 116
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Fax: (408) 432-3428

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1580 Oakland Road #C201
San Jose, CA 95131
Phone: (408) 453-3770
Fax: (408) 453-0398

FUTURE ELECTRONICS
2220 O'Toole Ave
San Jose, CA 95131
Phone: (408) 434-1122
Fax: (408) 433-0822
<http://www.future.ca>

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2220 O'Toole Ave
San Jose, CA 95131
Phone: (408) 434-0369
Fax: (408) 434-9599
<http://www.future.ca>

KENT ELECTRONICS
225 Charcot Avenue
San Jose, CA 95131
Phone: (408) 232-3000
Fax: (408) 944-4399

NEWARK ELECTRONICS
Toll Free: 1-800-367-3573

RICHEY ELECTRONICS
3230 Scott Boulevard
Santa Clara, CA 95054
Phone: (408) 654-9100
Fax: (408) 654-9204
<http://www.richeyelec.com>

STERLING ELECTRONICS
2159 Bering Drive
San Jose, CA 95131
Phone: (408) 435-0835
Fax: (408) 428-0108
<http://www.sterlink.com>

TIME ELECTRONICS
1339 Moffett Park Drive
Sunnyvale, CA 94089
Phone: (408) 734-9890
Toll Free: (800) 972-2080
Fax: (408) 734-1719
<http://www.time.avnet.com>

CALIFORNIA-Southern
Sales Office:
QUADREP SOUTHERN, INC.
15215 Alton Parkway, Suite 200
Irvine, CA 92718
Phone: (714) 727-4222
FAX: 714-727-4033

QUADREP SOUTHERN, INC.
11995 El Camino Real, Suite 305
San Diego, CA 92130
Phone: (619) 755-1188
Fax: (619) 793-9269

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1010 Sandhill Avenue
Carson, CA 90746-1373
Phone: (310) 632-4333
Fax: (310) 632-4301
<http://www.calswitch.com>

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2478 Fletcher Drive
Los Angeles, CA 90039
Phone: (213) 660-1310
Toll Free: (800) 421-8855
Fax: (213) 660-5130

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2060 East Francis
Ontario, CA 91761-5630
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Fax: (909) 947-2771

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San Diego, CA 92126
Phone: (619) 693-8222
Fax: (619) 530-1957

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Phone: (818) 865-0040
Fax: (818) 865-1340
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5150 Shoreham Place, Suite 220
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755 Sunrise Ave, Suite 150
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Fax: (619) 623-2891
<http://www.future.ca>

KENT ELECTRONICS
17815 Newhope Street, Suite R
Fountain Valley, CA 92708
Phone: (714) 556-5700
Fax: (714) 513-8915

KENT ELECTRONICS
6195 Cornerstone Court E, Suite 114
San Diego, CA 92121
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FAX: (619) 453-4477

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Inglewood, CA 90304
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Richardson, TX 75081
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Eugene, OR 97402
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Fax: (503) 342-7301

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Portland, OR 97211
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Fax: (503) 284-2728

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General Warren Blvd.
Malvern, PA 19355-0918
Phone: (610) 408-8000
Fax: (610) 408-8048

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Pittsburgh, PA 15238
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Fax: (412) 967-9610

GREAT LAKES CONTROLS
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Pittsburgh, PA 15017
Phone: (412) 221-2010
Fax: (412) 221-2080

TEXAS
MOTION DYNAMICS, INC.
1207 Glenville Drive
Richardson, TX 75081
Phone: (214) 690-3488
Fax: (214) 690-4477

MOTION DYNAMICS, INC.
9103 Emmott, Box 19 Bldg. 8, Suite A
Houston, TX 77040
Phone: (713) 896-7815
Fax: (713) 896-6817

UTAH
M.S.I. TECHNOLOGIES
9192 S. 300 W., Suite #12
Sandy, UT 84070
Phone: (801) 569-0600
Fax: (801) 569-0606

APPROXIMATELY
Phone: (414) 735-9155
Toll Free: (800) 236-2644
Fax: (414) 735-9752

WYOMING
M.S. I. TECHNOLOGIES
11211 E. Arapahoe Road, Suite #107
Englewood, CO 80112
Phone: (303) 792-5518
Fax: (303) 792-5519

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Alberta T5S 1H2
Phone: (403) 486-1645
Fax: (403) 484-6394

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**These distributors carry all Control
Products and provide local
technical support.**

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PTY LTD.**
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Campbelltown NSW 2560
Phone: (46) 29-3033
Fax: (46) 28-3122

Hampton, Victoria Office:
2, Small Street
Hampton, Victoria 3188
Phone: (9) 521-9011
Fax: (9) 592-4323

BRAZIL
RIFRAN ELETTRONICA LTD
Rua Baquirivu 529
04404-030 Sao Paulo
Phone: (11) 564-7522
Fax: (11) 564-5828

GREECE
INDELEC EUROPE SA
AUTOMATION & TECHNOLOGY CO
5 Solonos Str
152 32 Halandri, Greece
Phone: (01) 68 94 290
Fax: (01) 68 94 291

ISRAEL
EQUIPMENT LTD.
4 Bell St. (Hahistadrut Ave. 137A)
P. O. Box 10187, Haifa Bay 26111
Phone: (04) 414999
Fax: (04) 414173

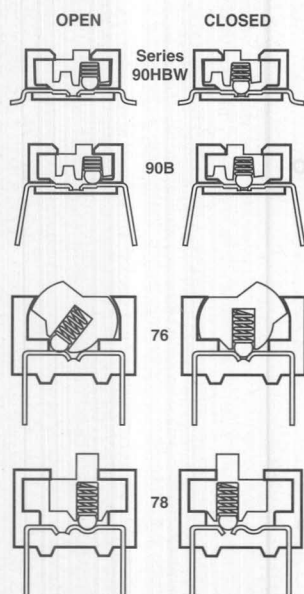
MEXICO
EQUIPOS Y CONTROL DIV.
COMMERCIAL S.A. DE C.E.
Gaviotas 54, Col. Granjas Modernas
CP07460 Mexico, D.F.
Phone: (5) 577-6311
Fax: (5) 781-8135

RUSSIA
PRO SOFT
17/21 Malaya Ekaterinskaya Street
Moscow 129 110
Phone: (95) 955-7412-18
Fax: (95) 261-5817

SINGAPORE
SERVO DYNAMICS PTE LTD.
Block 161, Kollang Way, #04-03/04
Kolam Ayer Industrial Park
Singapore 349427
Phone: 298-6011
Fax: 296-9276

SOUTH AFRICA
**MASS MEASURING SYSTEMS (PTY)
LTD.**
P.O. Box 979, 21 Orion Street
Germiston 1400
Phone: (11) 873-5555
Fax: (11) 873-1934

TAIWAN
JMTEK AUTOMATION CO. LTD.
No. 286-9, 6th Floor, Hsin-Ya Road
Kaohsiung City, Taiwan
Phone: (7) 812-5110
Fax: (7) 831-7893



SURFACE MOUNT SWITCHES

- Standard DIP Package Outline Includes PIANO-DIP®
- New Tactile Feedback, Board Mount Switches

THRU-HOLE DIP SWITCHES

- Consistent High Contact Pressure With Spring & Ball Contact System
- Standard Base Seal; Optional Top Tape Seal
- Large Selection of Types & Styles Includes Military Qualified Switches

SELECTION.....

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SURFACE MOUNT SWITCHES

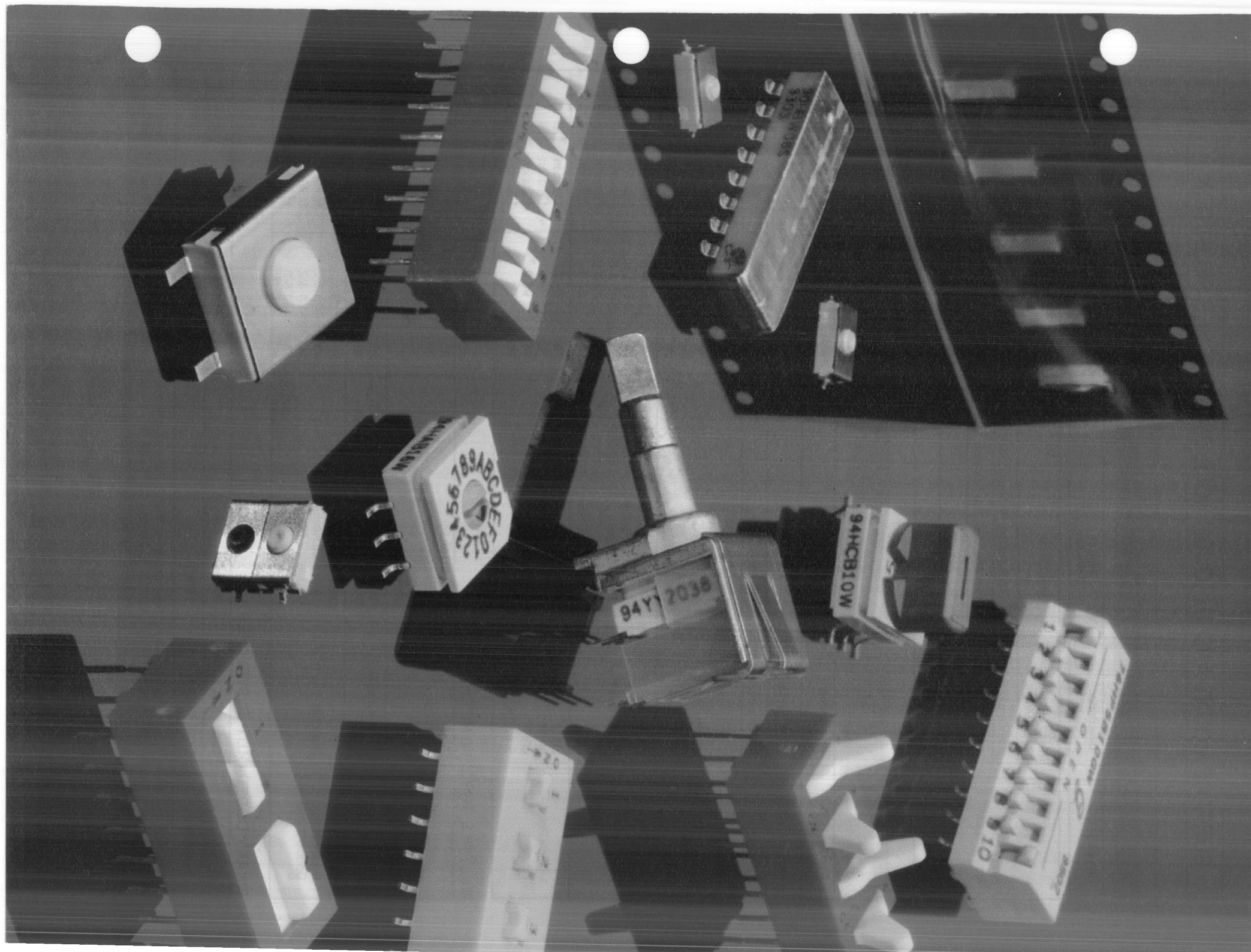
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THRU-HOLE DIP SWITCHES

(Also see Series 76, 78 and 90 Surface Mount Switches)

Circuitry	Description	Type of Actuation	Series	No. of Positions Available	No. of Actuators	Page Number
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SINGLE THROW SWITCHES

Single Pole, Single Throw	Machine Insertable	Recessed Slide	90	2-10	1/Station	B-12
	Standard	Raised Rocker	76	2-10 & 12	1/Station	B-13
		Recessed Rocker	76	2-10 & 12	1/Station	B-13
		Side Actuated	76	2-10 & 12	1/Station	B-13
		Slide*	78	2-10 & 12	1/Station	B-14
		Recessed Slide*	78	2-10	1/Station	B-14
	Military Qualified	Raised Rocker (MS83504/01)	76	2-10 & 12	1/Station	B-18
		Recessed Rocker (MS83504/02)	76	2-10 & 12	1/Station	B-18
		Side Actuated (MS83504/11)	76	2-10 & 12	1/Station	B-19
		Slide (MS83504/04)	78	2-10 & 12	1/Station	B-18
		Machine Insertable (MS83504/12)	90	2-10	1/Station	B-18
Multiple Pole, Single Throw	2PST	Slide*	78	1-5	1/Station	B-14
	3PST	Slide*	78	1-3	1/Station	B-14
	4PST	Slide*	78	1 & 2	1/Station	B-14
	5, 6, 7, 8, or 10PST	Slide*	78	1	1/Station	B-14

MULTIPLE THROW SWITCHES

Single Pole, Multiple Throw	Standard	Raised Rocker	76	2-4	1/Station	B-15
		Recessed Rocker	76	2-4	1/Station	B-15
		Toggle	76	2-4	1/Station	B-15
		Slide*	78	1-5	1/Station	B-15
	Military Qualified	Raised Rocker (MS38504/05)	76	2-4	1/Station	B-19
		Recessed Rocker (MS38504/06)	76	2-4	1/Station	B-19
Double Pole, Double Throw	Standard	Raised Rocker	76	1 & 2	1/Station	B-16
		Recessed Rocker	76	1 & 2	1/Station	B-16
		Toggle	76	1 & 2	1/Station	B-16
		Slide*	78	1 & 2	1/Station	B-16

BINARY CODED OUTPUT SWITCHES

Standard Code	Octal, BCD, & Hex	Rotary	94	8, 10 & 16	1	B-20, -21
Complement	Octal, BCD, & Hex	Rotary	94	8, 10 & 16	1	B-20, -21

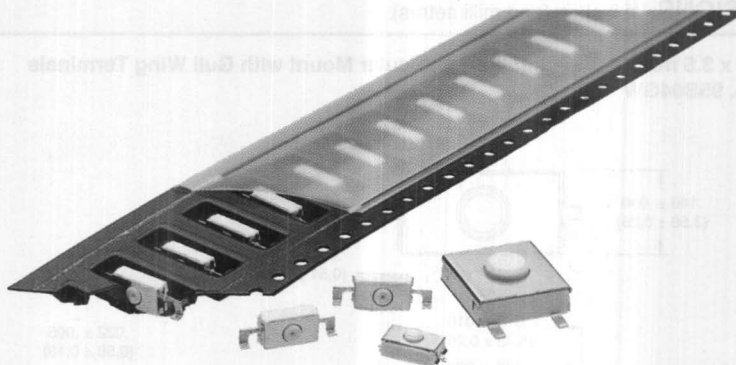
*Switch is also available with right angle termination. See page listed above and page B-23.

Grayhill Series 76 DIP Switches are covered by one or more of the following patents pending: 4,031,345, Canada 1,035,820 (1978), and Canada 1,055,551 (1979). Series 90 Switches are protected by patent numbers 4,590,344 and 4,670,630.

SERIES 95

FEATURES

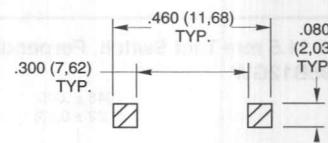
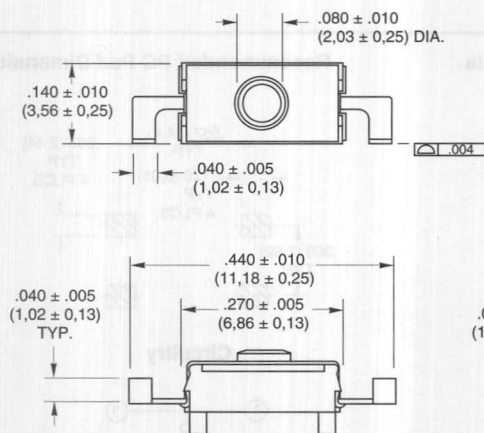
- Excellent Tactile Feedback
- Compatible with SMT Assembly Including Infrared and Vapor Phase
- Unique Flush or Offset Option for Right Angle Mounts



DIMENSIONS In inches (and millimeters)

6.9 mm x 3.5 mm Tact Switch, Right Angle Flush Mount Part No. 95B04RA

Recommended PC Pad Dimensions

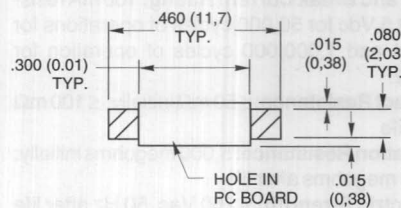
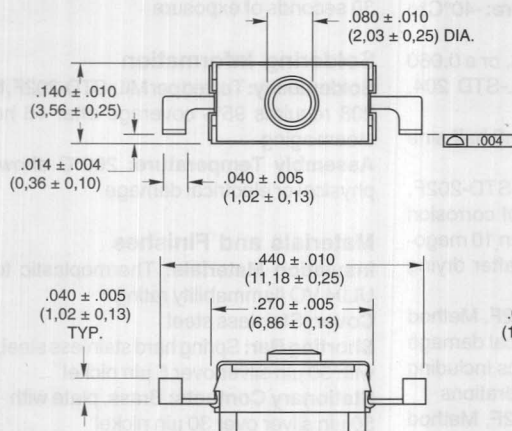


Circuitry



6.9 mm x 3.5 mm Tact Switch, Right Angle Offset Mount Part No. 95B04FA

Recommended PC Pad Dimensions



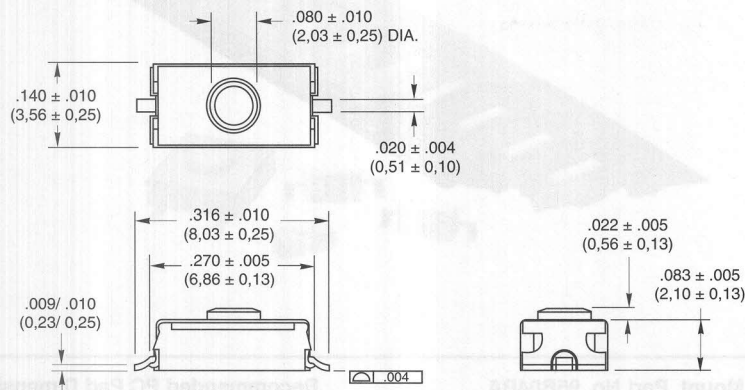
Circuitry



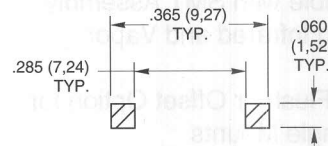
SURFACE MOUNT TACTILE SWITCHES

DIMENSIONS In inches (and millimeters)

6.9 mm x 3.5 mm Tact Switch, Perpendicular Mount with Gull Wing Terminals Part No. 95B04GW



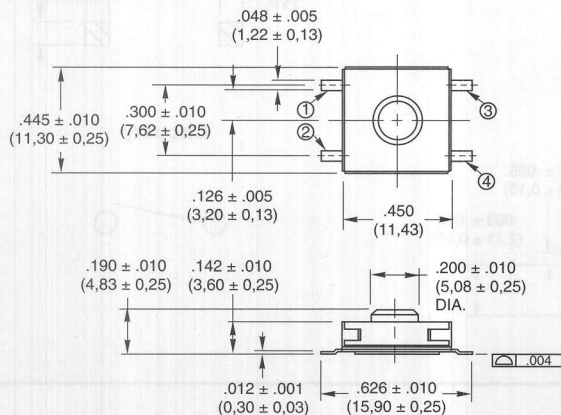
Recommended PC Pad Dimensions



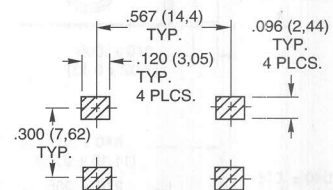
Circuitry



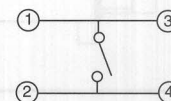
11.5 mm x 11.5 mm Tact Switch, Perpendicular Mount with Gull Wing Terminals Part No. 95B12GW



Recommended PC Pad Dimensions



Circuitry



Ratings

Make and Break Current Rating: 100 mA resistive at 5 Vdc for 50,000 cycles of operations for 95B04 and 1,000,000 cycles of operation for 95B12.

Contact Resistance: $\leq 50 \text{ m}\Omega$ initially; $\leq 100 \text{ m}\Omega$ after life

Insulation Resistance: 5,000 megohms initially; 1,000 megohms after life

Dielectric Strength: $\leq 250 \text{ Vac}$, 50 Hz after life

Contact Bounce: 10 milliseconds maximum

Mechanical

Actuation Force: 95B04 240 G \pm 60 G
95B12 300 G \pm 50 G

Button Travel: $0.012'' \pm 0.005''$ (0,305 mm \pm 0,127 mm) to fully actuate

Return Force: After actuation, the return force is no less than 50 G

Terminal Strength: Pass MIL-STD-202F, Method 211 to withstand 5 cycle bends

Environmental

Operating and Storage Temperature: -40°C to $+85^\circ\text{C}$

Vibration: Pass 10-2000 Hz at 15 G, or a 0.060 inch double amplitude test per MIL-STD 204, Condition B

Mechanical Shock: Pass 50 G, 11 mS half-sine test per MIL-STD 213B, Condition A

Moisture Resistance: Pass MIL-STD-202F, Method 106 showing no evidence of corrosion and insulation resistance greater than 10 megohms, 1,000 megohms at 250 Vac after drying period

Thermal Shock: Pass MIL-STD-202F, Method 107G showing no evidence of physical damage or change in electrical characteristics including normal contact resistance after 5 operations

Thermal Aging: Pass MIL-STD-202F, Method 108A, Test Condition D. Requires operation at 125°C for 1,000 hours. Measurements at 500 and 1,000 hours of exposure showing no more than 50% change in contact resistance for test duration

Flammability: Test to IEC Standard 695-2-2 for 30 seconds of exposure

Soldering Information

Solderability: Tested per MIL-STD-202F, Method 208 requires 95% coverage after 16 hours of steam aging

Assembly Temperature: 260°C showing no physical or electrical damage

Materials and Finishes

Insulation Materials: Thermoplastic to meet UL94 VO flammability rating

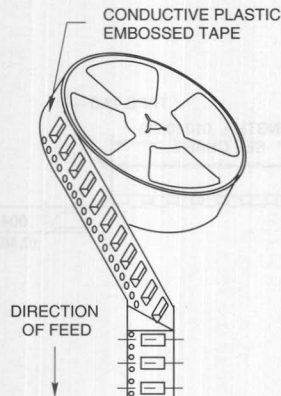
Cover: Stainless steel

Shorting Bar: Spring hard stainless steel, plated with 50 μin silver over 5 μin nickel

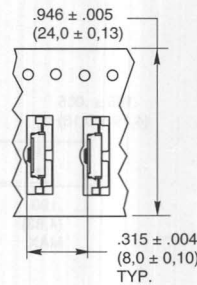
Stationary Contacts: Brass, plate with 50 μin silver over 30 μin nickel

Terminals: Brass, 100 μin solder over 50 μin silver over 30 μin nickel

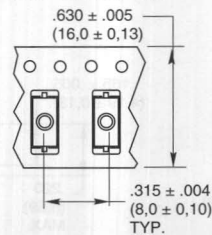
Meets requirements of EIA 481-2 or EIA 481-3



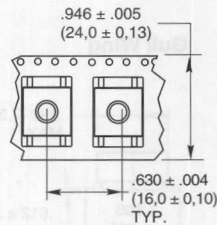
**PART NO. 95B04FA
AND 95B04RA**



PART NO. 95B04GW



PART NO. 95B12GW



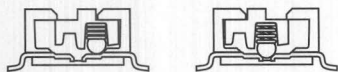
Part No. 95B12GW—each reel contains 750 switches with a 15.35 inch (390 mm) minimum leader and a 6.30 inch (160 mm) minimum trailer.

Part Nos. 95B04FA, 95B04RA and 95B04GW—each reel contains 2000 switches with a 15.35 inch (390 mm) minimum leader and a 6.30 inch (160 mm) minimum trailer.

Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill. Evaluation reels containing 25 switches are available. Contact Sales Office.

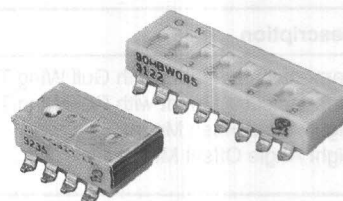
SURFACE MOUNT DIP SWITCH

SERIES 90HB



FEATURES

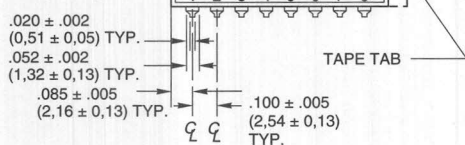
- Compatible With SMT Assembly, Including Infrared Reflow and Vapor-Phase
- Top Seal Withstands High Pressure Aqueous Cleaning
- Reliable Spring and Ball Contact



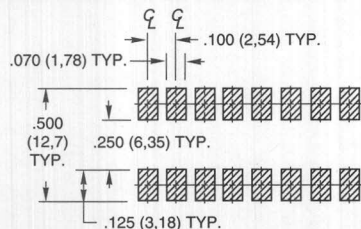
DIMENSIONS In inches (and millimeters)

Top View—Gull Wing

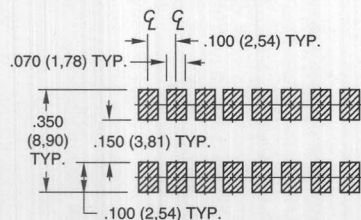
SWITCH IS PACKAGED AS SHOWN HERE WITH ALL POSITIONS ON



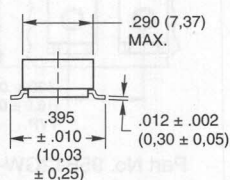
Recommended PC Pad Dimensions—Gull Wing



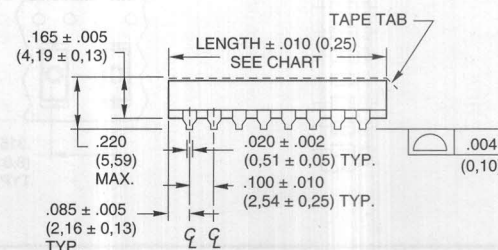
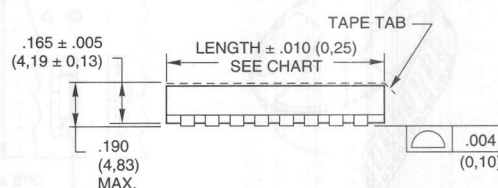
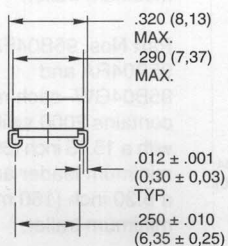
Recommended PC Pad Dimensions—J-Bend



Gull Wing

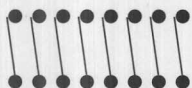


J-Bend



CIRCUITRY

As viewed from the top of the switch in the positions shown in the drawing.



SPECIFICATIONS

See page B-17.

ORDERING INFORMATION—Tape and Reel Packaging

See page B-11.

ORDERING INFORMATION—Tube Packaging Each tube is 19.5 inches long.

Gull Wing Part Number*	J Bend Part Number*	No. of Positions	Length Inches	Length Metric	Number Per Tube
90HBW02S	90HBJ02S	2	.270"	6,9 mm	60
90HBW03S	90HBJ03S	3	.370"	9,4 mm	47
90HBW04S	90HBJ04S	4	.470"	11,9 mm	37
90HBW05S	90HBJ05S	5	.570"	14,5 mm	31
90HBW06S	90HBJ06S	6	.670"	17,0 mm	26
90HBW07S	90HBJ07S	7	.770"	19,6 mm	23
90HBW08S	90HBJ08S	8	.870"	22,1 mm	20
90HBW09S	90HBJ09S	9	.970"	24,6 mm	18
90HBW10S	90HBJ10S	10	1.070"	27,2 mm	16

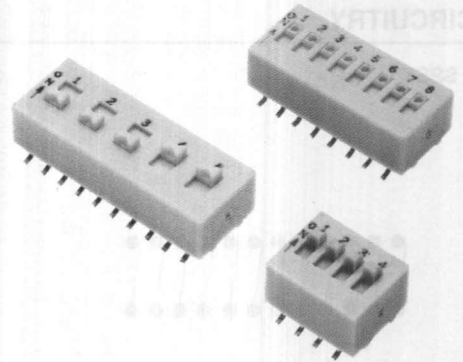
The "S" at the end of the part number denotes top tape seal versions. To order without top tape seal, leave the "S" off the part number when ordering.

Available from your local Grayhill Distributor. Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 78H

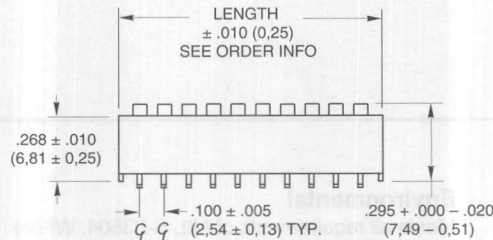
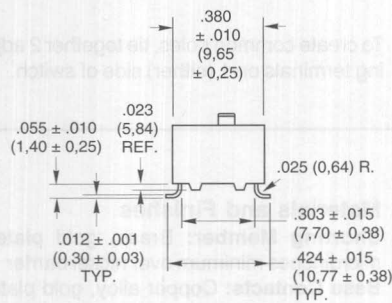
FEATURES

- Compatible with SMT Assembly Including Infrared Reflow and Vapor-Phase
- Circuitry not Offered in any Other Surface Mount Configuration
- Reliable Spring and Ball Contact



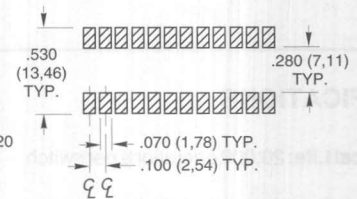
DIMENSIONS In inches (and millimeters)

SPST, Top Actuated, Slide Operated

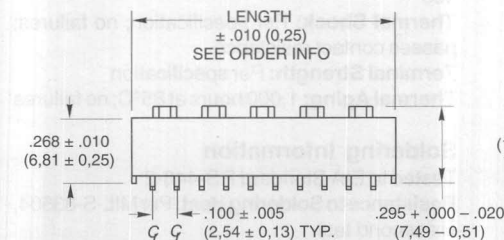
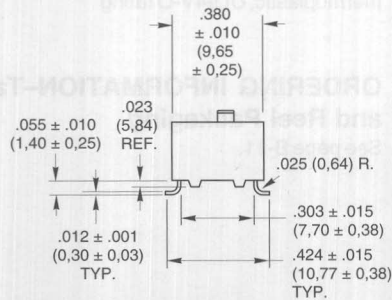


Note:
Recessed slides have a dimple
for tool actuation. For recessed slides
the .295 dimension does not apply.

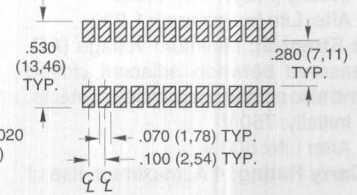
Recommended PC Pad Dimensions



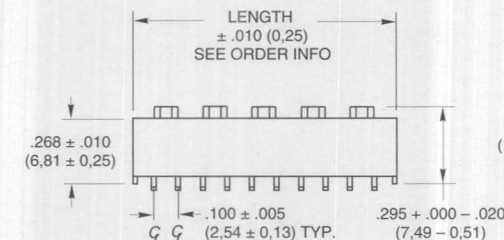
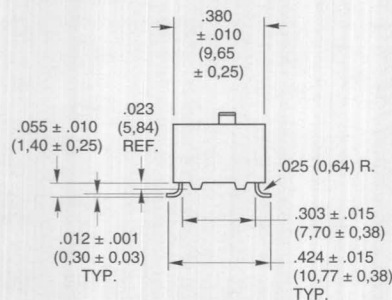
2PST, Top Actuated, Slide Operated



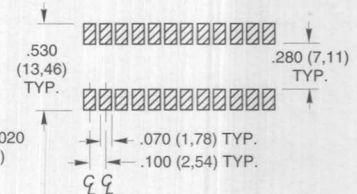
Recommended PC Pad Dimensions



SPDT, Top Actuated, Slide Operated



Recommended PC Pad Dimensions





To create common poles, tie together 2 adjoining terminals on 1 (either) side of switch.

SPECIFICATIONS

Ratings

Mechanical Life: 20,000 operations per switch position

Make and Break Current Rating: 10,000 operations per switch position at 1 mA, 5 Vdc; 50 mA, 30 Vdc; or 150 mA, 30 Vdc.

Contact Resistance:

Initially: $\leq 30 \text{ m}\Omega$

After Life: $\leq 100 \text{ m}\Omega$ at 10 mA,
50 Vdc, open circuit

Insulation Resistance: Minimum, at 100 Vdc between adjacent closed contacts and also across open switch contacts.

Initially (megohms): 2,000

After Life (megohms): 1,000

Dielectric Strength: Minimum voltage (AC, RMS) measured between adjacent closed contacts and also across open switch contacts.

Initially: 750 V

After Life: 500 V

Current Carry Rating: 4 A, maximum rise of 20°C

Switch Capacitance: 2 pF at 1 megahertz

Operating Temperature: -40°C to $+85^\circ\text{C}$

Storage Temperature: -55°C to $+85^\circ\text{C}$

SMT Processing Temperature: 260°C (1 pass)

Environmental

Meets all requirements of MIL-S-83504. Where Grayhill performance is superior, the MIL spec is listed in parentheses.

Vibration: Per method 204, Test Condition B, 1 microsecond opening (10 microseconds allowed)

Mechanical Shock: Per Method 213, Test Condition A, 1 microsecond opening (10 microseconds allowed)

Moisture Resistance: Per specification, Method 106

Thermal Shock: Per specification; no failures; passes contact resistance

Terminal Strength: Per specification

Thermal Aging: 1,000 hours at 85°C ; no failures

Soldering Information

Tested to EIA Standard RS-448-2

Resistance to Soldering Heat: Per MIL-S-83504, six second test

Tape Seal: Provided without tape seal. Contact Grayhill if tape seal is required

Recommended Processing Temperature: 220°C – 230°C

Processing Position: Switch is to be processed with all actuators in the closed (on) position as shipped

Materials and Finishes

Shorting Member: Brass, gold plated 10 microinches minimum over nickel barrier

Base Contacts: Copper alloy, gold plated 10 microinches minimum over nickel barrier

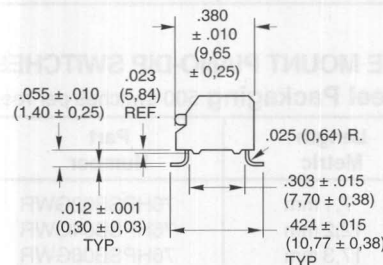
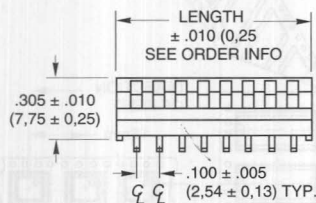
Terminals: Copper alloy, solder plated over nickel barrier

Solderability: Per MIL-STD-202 Method 208

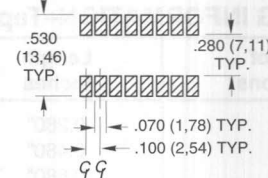
Non-Conductive Parts: Cover is natural color thermoplastic, actuators are natural thermoplastic, UL94V-O rating

ORDERING INFORMATION—Tape and Reel Packaging

See page B-11.



Recommended PC Pad Dimensions



CIRCUITRY

As viewed from the top of the switch in the positions shown in the drawing.



SPECIFICATIONS

Ratings

Mechanical Life: 20,000 operations per switch position

Make and Break Current Rating: 10,000 operations per switch position at 1 mA, 5Vdc; 50 mA, 30 Vdc; or 150 mA, 30 Vdc

Contact Resistance:

Initially $\leq 30 \text{ m}\Omega$

After life $\leq 100 \text{ m}\Omega$ at 10 mA, 50 Vdc, open circuit

Insulation Resistance:

Minimum, at 100 Vdc between adjacent closed contacts and also across open switch contacts

Initially (megohms) 2,000

Dielectric Strength: Minimum voltage (AC, RMS) measured between adjacent closed contacts and also across open switch contacts.

Initially 750 V

After life 500 V

Current Carry Rating: 5 A, maximum rise of 20°C

Switch Capacitance: 2 pF at 1 megahertz

Operating Temperature: -40°C to +85°C

Storage Temperature: -55°C to +85°C

SMT Processing Temperature: 260°C max. (1 pass)

Environmental

Meets all requirements of MIL- S-83504. Where Grayhill performance is superior, the MIL spec is listed in parentheses.

Vibration: Per method 204, Test Condition B 1 microsecond opening (10 microseconds allowed)

Mechanical Shock: Per Method 213, Test Condition A. 1 microsecond opening (10 microseconds allowed)

Moisture Resistance: Per specification, Method 106.

Thermal Shock: Per specification; no failures; passes contact resistance.

Terminal Strength: Per specification.

Thermal Aging: 1,000 hours at 85°C; no failures.

Soldering Information

Tested to EIA Standard RS-448-2.

Resistance to Soldering Heat: Per MIL-S-83504, six second test

Tape Seal: Provided without tape seal. Contact Grayhill if tape seal is required.

Processing Temperature: 220°C–230°C recommended

Processing Position: Switch is to be processed with all actuators in the closed (on) position as shipped.

Materials and Finishes

Shorting Member: Brass, gold plated 10 micro-inches minimum over nickel barrier.

Base Contacts: Copper alloy, gold plated 10 microinches minimum over nickel barrier.

Terminals: Copper alloy, solder plated over nickel barrier.

Solderability: Per MIL-STD-202, Method 208

Non-Conductive Parts: Cover is natural color thermoplastic, actuators are white thermoplastic, UL94V–O rating.

ORDERING INFORMATION–Tape and Reel Packaging

See page B-11.

TAPE AND REEL PACKAGING INFORMATION

SERIES 90HBW SURFACE MOUNT DIP SWITCHES

ORDERING INFORMATION—Tape and Reel Packaging 750 switches per reel.

No. of Positions	Length Inches	Length Metric	Gull Wing Part Number	J Bend Part Number
2	.270"	6,9 mm	90HBW02SR	90HBJ02SR
3	.370"	9,4 mm	90HBW03SR	90HBJ03SR
4	.470"	11,9 mm	90HBW04SR	90HBJ04SR
5	.570"	14,48 mm	90HBW05SR	90HBJ05SR
6	.670"	17,0 mm	90HBW06SR	90HBJ06SR
7	.770"	19,56 mm	90HBW07SR	90HBJ07SR
8	.870"	22,1 mm	90HBW08SR	90HBJ08SR
9	.970"	24,64 mm	90HBW09SR	90HBJ09SR
10	1.070"	27,2 mm	90HBW10SR	90HBJ10SR

SERIES 76HP WITH SUFFIX GW SURFACE MOUNT PIANO-DIP SWITCHES

ORDERING INFORMATION—Tape and Reel Packaging 500 switches per reel.

No. of Positions*	Length Inches	Length Metric	Part Number
2	0.280"	7,1 mm	76HPSB02GWR
4	0.480"	12,2 mm	76HPSB04GWR
6	0.680"	17,3 mm	76HPSB06GWR
8	0.880"	22,4 mm	76HPSB08GWR
9	0.980"	24,9 mm	76HPSB09GWR
10	1.080"	27,4 mm	76HPSB10GWR
12	1.280"	32,5 mm	76HPSB12GWR

* For other lengths, contact Grayhill, Inc.

SERIES 78H WITH SUFFIX GW SURFACE MOUNT DIP SWITCHES

ORDERING INFORMATION*—Tape and Reel Packaging 500 switches per reel.

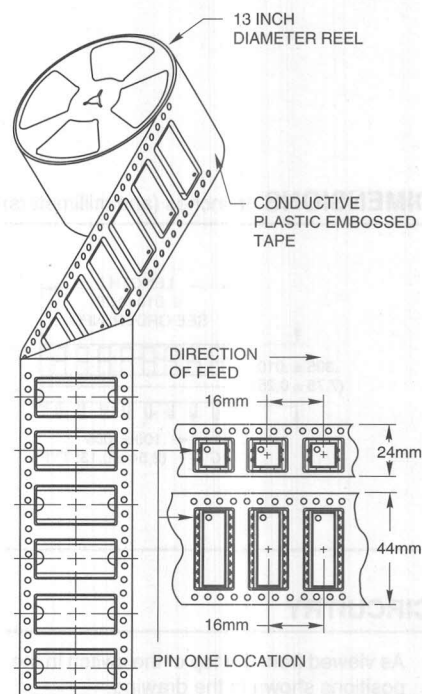
Single quantity provided in tube or in tube multiple plus required part number.

Switch Type	No. of Positions	Length—Inches (mm)	Part Number
Series 78 Surface Mount Raised Slide	2	0.280 (7,1)	78HB02GW
	4	0.480 (12,2)	78HB04GW
	6	0.680 (17,3)	78HB06GW
	8	0.880 (22,4)	78HB08GW
	10	1.080 (27,4)	78HB10GW
Series 78 Surface Mount Recessed Slide	2	0.280 (7,1)	78HRB02GW
	4	0.480 (12,2)	78HRB04GW
	6	0.680 (17,3)	78HRB06GW
	8	0.880 (22,4)	78HRB08GW
	10	1.080 (27,4)	78HRB10GW
Series 78 Surface Mount Raised Slide Single Pole Double Throw	1	0.280 (7,1)	78HJ01GW
	2	0.480 (12,2)	78HJ02GW
	3	0.680 (17,3)	78HJ03GW
	4	0.880 (22,4)	78HJ04GW
	5	1.080 (27,4)	78HJ05GW
Series 78 Surface Mount Raised Slide Double Pole Single Throw	1	0.280 (7,1)	78HF01GW
	2	0.480 (12,2)	78HF02GW
	3	0.680 (17,3)	78HF03GW
	4	0.880 (22,4)	78HF04GW
	5	1.080 (27,4)	78HF05GW

* Contact Grayhill for other switch lengths, sealing, or packaging

TAPE AND REEL PACKAGING

Meets requirements of EIA 481-2 or EIA 481-3

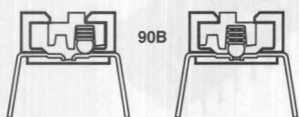


Each reel has a 15.750 inch (390 mm) minimum leader and a 6.30 inch (160 mm) minimum trailer.

Available from your local Grayhill Distributor
Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill. Evaluation reels containing 25 switches are available. Contact Sales Office.

MACHINE INSERTABLE DIP SWITCH

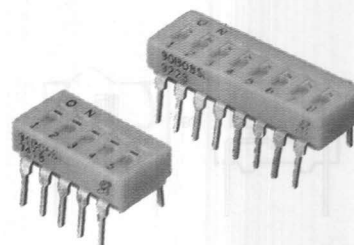
SERIES 90



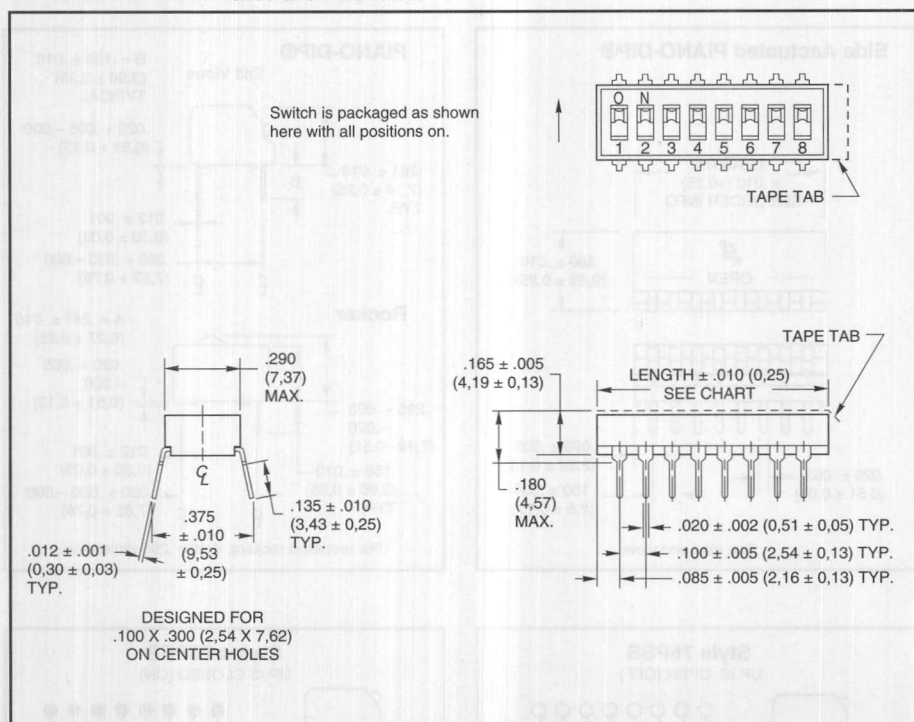
FEATURES

- Tested for TO-116 Equipment
- Up to 10 Positions
- High Pressure, Reliable Contacts
- Molded (Sealed) Base and Optional Top Seal
- Pressure Sensitive Adhesive for Non-Washable Processes

MIDIP® SWITCH



DIMENSIONS In inches and millimeters



CIRCUITRY

As viewed from the top of the switch in the positions shown in the drawing.



ORDERING INFORMATION—Tube Packaging Each tube is 19.5 inches long.

Part Number	No. Of Stations	Length Inches	Length Metric	Number Per Tube
90B02S	2	.270"	6,9 mm	60
90B03S	3	.370"	9,4 mm	47
90B04S	4	.470"	11,9 mm	37
90B05S	5	.570"	14,5 mm	31
90B06S	6	.670"	17,0 mm	26
90B07S	7	.770"	19,6 mm	23
90B08S	8	.870"	22,1 mm	20
90B09S	9	.970"	24,6 mm	18
90B10S	10	1.070"	27,2 mm	16

The "S" at the end of the part number denotes top tape seal versions. To order without top tape seal, leave the "S" off the part number when ordering.

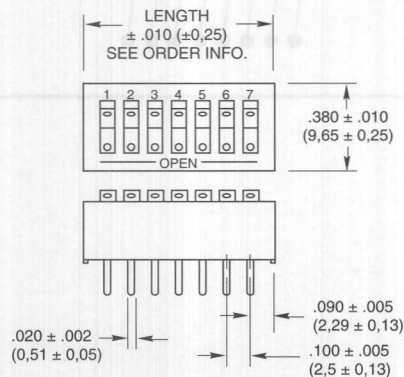
Available from your local Grayhill Distributor
Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ADDITIONAL INFORMATION

For Specifications, see page B-17.
For Options and Accessories, see page B-24.

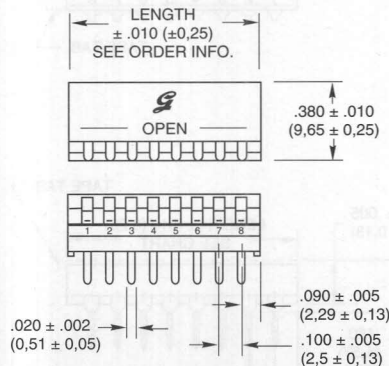
DIMENSIONS In inches (and millimeters)

Rocker and Recessed Rocker



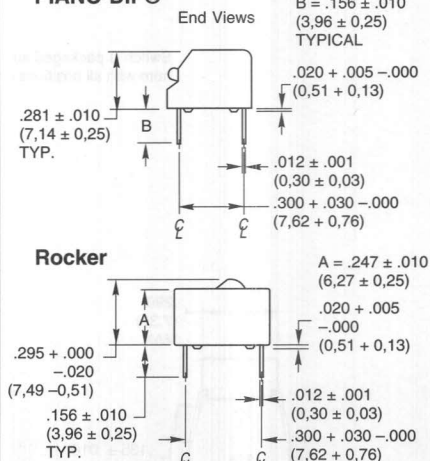
See also end view.

Side Actuated PIANO-DIP®



See also end view.

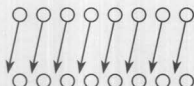
PIANO-DIP®



For recessed rockers, delete .295 dimension.

CIRCUITRY

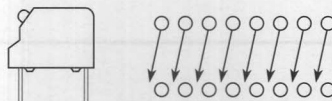
Styles 76SB and 76RSB



Typical circuit diagram with actuator as shown
in the dimension drawing.

Style 76PSB

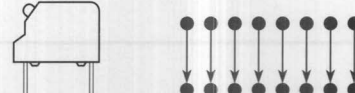
UP IS OPEN (OFF)



Actuator shown in the up position.

Styles 76PRB

UP IS CLOSED (ON)



Actuator shown in the up position.

ORDERING INFORMATION

No. Of Positions	Length Inches	Length Metric	No./ Tube	Raised Rocker	Recessed Rocker	PIANO-DIP® Up is Off	PIANO-DIP® Up is On
2	0.280"	7,1mm	35	76SB02	76RSB02	76PSB02	76PRB02
3	0.380"	9,7mm	27	76SB03	76RSB03	76PSB03	76PRB03
4	0.480"	12,2mm	21	76SB04	76RSB04	76PSB04	76PRB04
5	0.580"	14,7mm	18	76SB05	76RSB05	76PSB05	76PRB05
6	0.680"	17,3mm	15	76SB06	76RSB06	76PSB06	76PRB06
7	0.780"	19,8mm	13	76SB07	76RSB07	76PSB07	76PRB07
8	0.880"	22,4mm	12	76SB08	76RSB08	76PSB08	76PRB08
9	0.980"	24,9mm	10	76SB09	76RSB09	76PSB09	76PRB09
10	1.080"	27,4mm	9	76SB10	76RSB10	76PSB10	76PRB10
12	1.280"	32,5mm	8	76SB12	76RSB12	76PSB12	76PRB12

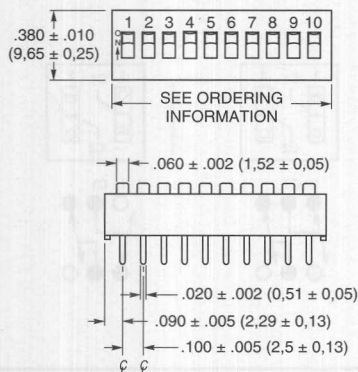
A top tape seal is required for switches that are machine soldered or heavily cleaned after hand soldering. To order top seal versions, add "S" to the Grayhill part number.

Available from your local Grayhill Distributor
Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

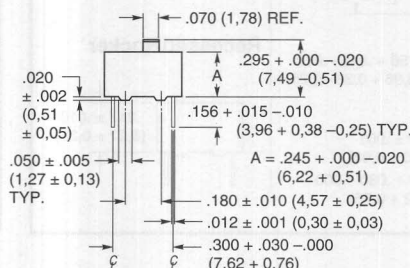
For Specifications, see page B-17.
For Options and Accessories, see page B-24.

DIMENSIONS In inches (and millimeters)

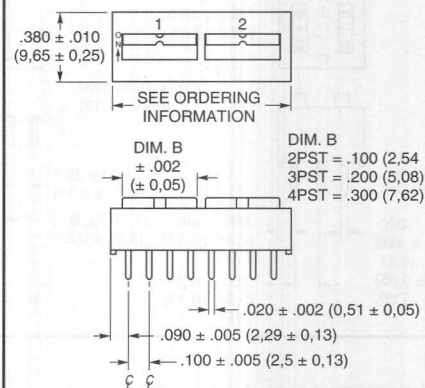
Single Pole/Single Throw Switch in Raised and Recessed Slides



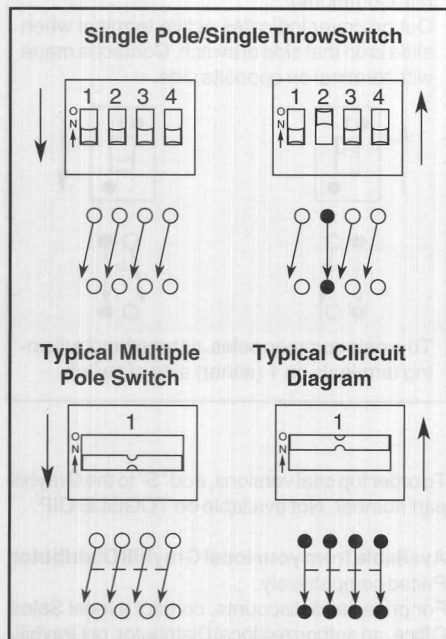
Note:
Recessed slides have a dimple for
tool actuation. For recessed slides,
the .295 dimension does not apply.



Typical Multiple Pole Switch with Raised Slides (Switch shown here is 78H02, 4PST)



CIRCUITRY



ORDERING INFORMATION

Circuitry	No. Of Positions	Length Inches	Length Metric	No./ Tube	Raised Slides	Recessed Slides
SPST	2	0.280"	7,1mm	35	78B02	78RB02
	3	0.380"	9,7mm	27	78B03	78RB03
	4	0.480"	12,2mm	21	78B04	78RB04
	5	0.580"	14,7mm	18	78B05	78RB05
	6	0.680"	17,3mm	15	78B06	78RB06
	7	0.780"	19,8mm	13	78B07	78RB07
	8	0.880"	22,4mm	12	78B08	78RB08
	9	0.980"	24,9mm	10	78B09	78RB09
	10	1.080"	27,4mm	9	78B10	78RB10
	12	1.280"	32,5mm	8	78B12	78RB12
2PST	1	0.280"	7,1mm	35	78F01	Recessed Slides Not Available
	2	0.480"	12,2mm	21	78F02	
	3	0.680"	17,3mm	15	78F03	
	4	0.880"	22,4mm	12	78F04	
	5	1.080"	27,4mm	9	78F05	
3PST	1	0.380"	9,7mm	27	78G01	Not Available
	2	0.680"	17,3mm	15	78G02	
	3	0.980"	24,9mm	10	78G03	
4PST	1	0.480"	12,2mm	21	78H01	Not Available
	2	0.880"	22,4mm	12	78H02	

For switches with 5, 6, 7, 8, or 10PST circuitry, contact Grayhill.

A top tape seal is required for switches that are machine soldered or heavily cleaned after hand soldering. To order top seal versions, add "S" to the Grayhill part number.

Available from your local Grayhill Distributor
Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ADDITIONAL INFORMATION

For Specifications see page B-17.
For other Options and Accessories, see pages B-23 and B-24.

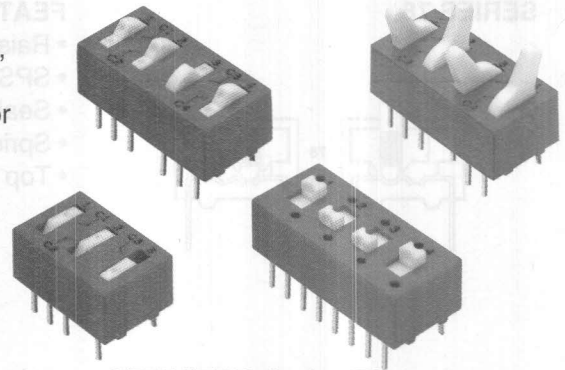


SPDT DIP SWITCHES

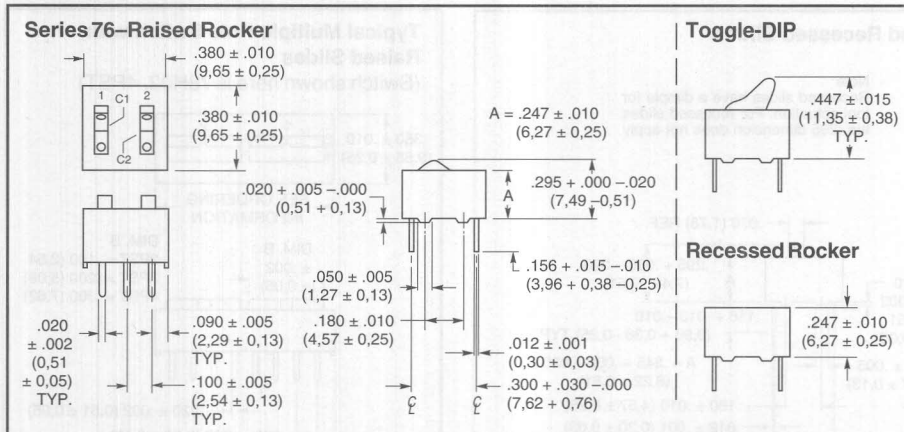
SERIES 76 AND 78

FEATURES

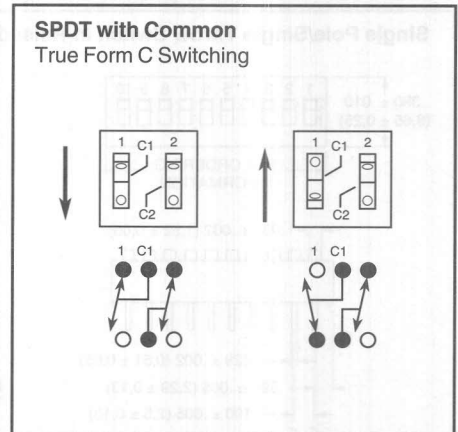
- Raised and Recessed Rocker, and Toggle Actuated Styles
- SPDT with a Common Pole, or SPDT with 2 Isolated Circuits
- Spring and Ball Contact
- Top Tape Seal Option for Most Styles



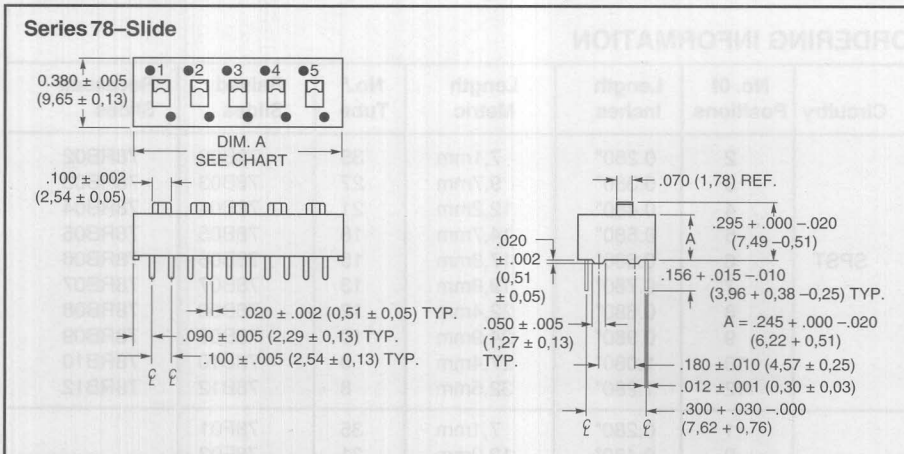
DIMENSIONS—Series 76 In inches (and millimeters)



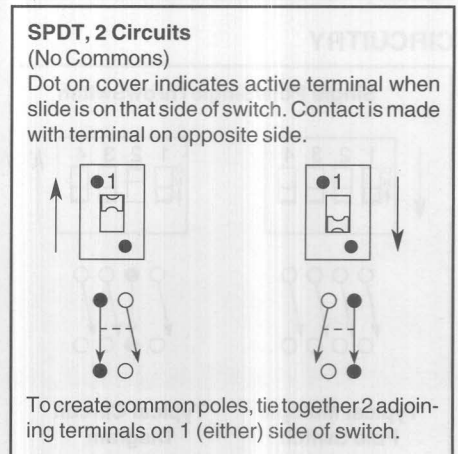
CIRCUITRY—Series 76



DIMENSIONS—Series 78 In inches (and millimeters)



CIRCUITRY—Series 78



ORDERING INFORMATION

Cir-cuity	Posi-tions	Length Inches	Length Metric	No./ Tube	Raised Type	Recessed Rockers	TOGGLE-DIP
SPDT Form C	2	0.380"	9,7mm	27	76SC02	76RSC02	76STC02
	3	0.580"	14,7mm	18	76SC03	76RSC03	76STC03
	4	0.780"	19,8mm	13	76SC04	76RSC04	76STC04
SPDT 2 Cir-cuits	1	0.280"	7,1mm	35	78J01	—	—
	2	0.480"	12,2mm	21	78J02	—	—
	3	0.680"	17,3mm	15	78J03	—	—
	4	0.880"	22,4mm	12	78J04	—	—
	5	1.080"	27,4mm	9	78J05	—	—

To order top seal versions, add "S" to the Grayhill part number. Not available on TOGGLE-DIP.

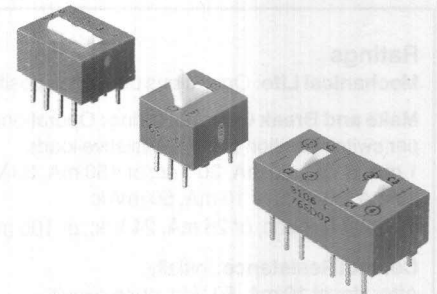
Available from your local Grayhill Distributor
Priced competitively.
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ADDITIONAL INFORMATION

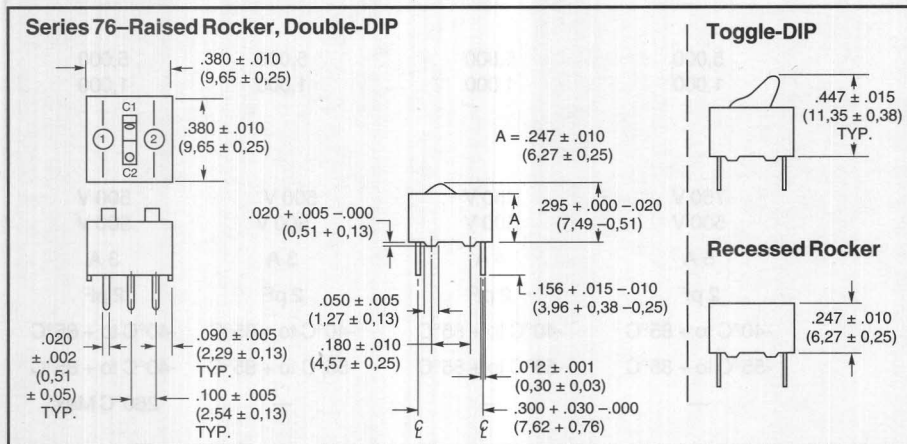
For Specifications, see page B-17.
For other Options, see pages B-23 and B-24.

FEATURES

- Raised and Recessed Rocker, and Toggle Actuated Styles
- DPDT with Common Poles, or DPDT with 4 Isolated Circuits
- Spring and Ball Contact
- Top Tape Seal Option for Most Styles

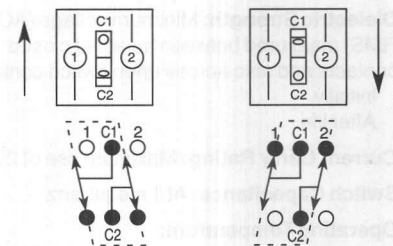


DIMENSIONS—Series 76 In inches (and millimeters)

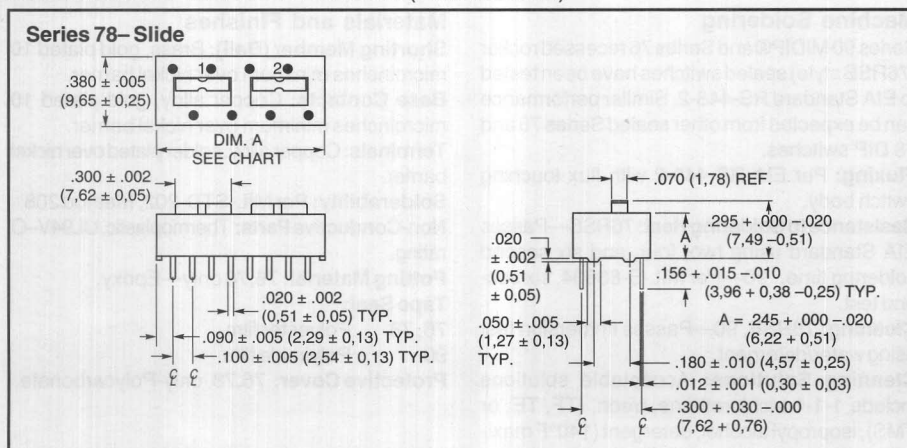


CIRCUITRY—Series 76

DPDT with Commons True Form D Switching



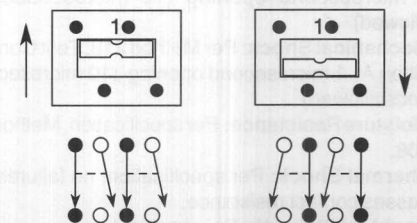
DIMENSIONS—Series 78 In inches (and millimeters)



CIRCUITRY—Series 78

DPDT, 4 Circuits (No Commons)

Dot on cover indicates active terminal when slide is on that side of switch. Contact is made with terminal on opposite side.



To create common poles, tie together 2 adjoining terminals on 1 (either) side of switch.

ORDERING INFORMATION

Circuitry	Positions	Length Inches	Length Metric	No./Tube	Raised Type	Recessed Rockers	TOGGLE-DIP
DPDT Form D	1	0.380"	9,7mm	27	76SD01	76RSD01	76STD01
	2	0.780"	19,8mm	13	76SD02	76RSD02	76STD02
DPDT 4 Circ.	1	0.480"	12,2mm	21	78K01	—	—
	2	0.880"	22,4mm	12	78K02	—	—

A top tape seal is required for switches that are machine soldered or heavily cleaned after hand soldering. To order top seal versions, add "S" to the Grayhill part number. Not available on TOGGLE-DIP.

Available from your local Grayhill Distributor. Priced competitively. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ADDITIONAL INFORMATION

For Specifications, see page B-17.

For other Options, see pages B-23 and B-24.

DIP SWITCH SPECIFICATIONS

SPECIFICATIONS—Standard and Military Qualified Styles

Ratings	76	78	90B	90HB
Mechanical Life: Operations per switch position	20,000	20,000	5,000	5,000
Make and Break Current Rating: Operations per switch position at these resistive loads 1 mA, 5 Vdc; 50 mA, 30 Vdc; or 150 mA, 30 Vdc 10 mA, 30 Vdc; or 10 mA, 50 mVdc 10 mA, 50 mVdc; or 25 mA, 24 Vdc; or 100 mA, 6 Vdc	10,000 — —	10,000 — —	— 2,000 —	— — 2,000
Contact Resistance: Initially After life, at 10 mA, 50 Vdc, open circuit	≤ 30 mΩ ≤ 100 mΩ	≤ 30 mΩ ≤ 100 mΩ	≤ 20 mΩ ≤ 100 mΩ	≤ 20 mΩ ≤ 100 mΩ
Insulation Resistance: Minimum, at 100 Vdc between adjacent closed contacts and also across open switch contacts Initially (megohms) After life (megohms)	5,000 1,000	5,000 1,000	5,000 1,000	5,000 1,000
Dielectric Strength: Minimum voltage (AC, RMS) measured between adjacent closed contacts and also across open switch contacts. Initially After life	750 V 500 V	750 V 500 V	500 V 500 V	500 V 500 V
Current Carry Rating: Maximum rise of 20°C	5 A	4 A	3 A	3 A
Switch Capacitance: At 1 megahertz	2 pF	2 pF	2 pF	2 pF
Operating Temperature:	-40°C to + 85°C	-40°C to + 85°C	-40°C to + 85°C	-40°C to + 85°C
Storage Temperature:	-55°C to + 85°C	-55°C to + 85°C	-55°C to + 85°C	-40°C to + 85°C
SMT Processing Temperature (90HB):	—	—	—	260°C Max.

Environmental

Meets all requirements of MIL- S-83504. Where Grayhill performance is superior, the MIL spec is listed in parentheses.

Vibration: Per method 204, Test Condition B 1 microsecond opening (10 microseconds allowed)

Mechanical Shock: Per Method 213, Test Condition A. 1 microsecond opening (10 microseconds allowed)

Moisture Resistance: Per specification, Method 106.

Thermal Shock: Per specification; no failures; passes contact resistance.

Terminal Strength: Per specification

Thermal Aging: 1,000 hours at 85°C; no failures.

Surface Mount Switches (90HBW)

Additional Information

Recommended Processing Temperature: 220°C–230°C

Processing Position: Switch is to be processed with all actuators in the closed (on) position as shipped.

Machine Soldering

Series 90 MIDIP® and Series 76 recessed rocker (76RSB style) sealed switches have been tested to EIA Standard RS-448-2. Similar performance can be expected from other sealed Series 76 and 78 DIP switches.

Fluxing: Per EIA RS-448-2 with flux touching switch body.

Resistance to Soldering Heat: 76RSB—Passes EIA Standard using two, four, and six second soldering time. 90—Per MIL-S-83504, six second test.

Cleaning: 76RSB, 90—Passes immersion test using water/detergent.

Cleaning Solutions: Acceptable solutions include 1-1-1 trichlorethane, freon, (TF, TE, or TMS), isopropyl alcohol, detergent (140°F maximum). Terpene acceptable for Series 90 only. Solutions which are not recommended include acetone, methylene chloride, freon TMC.

Tape Seal Integrity: Passes gross leak test using 125°C flourinert for 20 seconds minimum. Reference MIL-STD-202, Method 112.

Materials and Finishes

Shorting Member (Ball): Brass, gold plated 10 microinches minimum over nickel barrier.

Base Contacts: Copper alloy, gold plated 10 microinches minimum over nickel barrier.

Terminals: Copper alloy, solder plated over nickel barrier.

Solderability: Per MIL-STD-202, Method 208

Non-Conductive Parts: Thermoplastic, UL94V-O rating.

Potting Material: 76,78 only—Epoxy.

Tape Seal:

76, 78 Polyester film

90 Polyimide film

Protective Cover: 76,78, only—Polycarbonate.

MILITARY QUALIFIED DIP SWITCHES

SERIES 76, 78, AND 90

FEATURES

- All switches listed on these pages are qualified to MS83504

TOP SEAL

All Grayhill DIP Switch part numbers ending in S have a tape seal. This is now the standard for

military qualified DIP switches. If you order by the military M number, you will also get the tape

seal version. The exception is the toggle actuated styles which are not top tape sealed.

ORDERING INFORMATION

Circuitry	Description	Number of Positions	Military Part Number	Grayhill Part Number
Single Pole/Single Throw	Raised Rocker	02	M83504/01-022	76MSB02S
Single Pole/Single Throw	Raised Rocker	03	M83504/01-023	76MSB03S
Single Pole/Single Throw	Raised Rocker	04	M83504/01-024	76MSB04S
Single Pole/Single Throw	Raised Rocker	05	M83504/01-025	76MSB05S
Single Pole/Single Throw	Raised Rocker	06	M83504/01-026	76MSB06S
Single Pole/Single Throw	Raised Rocker	07	M83504/01-027	76MSB07S
Single Pole/Single Throw	Raised Rocker	08	M83504/01-028	76MSB08S
Single Pole/Single Throw	Raised Rocker	09	M83504/01-029	76MSB09S
Single Pole/Single Throw	Raised Rocker	10	M83504/01-030	76MSB10S
Single Pole/Single Throw	Raised Rocker	12	M83504/01-032	76MSB12S
Single Pole/Single Throw	Recessed Rocker	02	M83504/02-022	76MRSB02S
Single Pole/Single Throw	Recessed Rocker	03	M83504/02-023	76MRSB03S
Single Pole/Single Throw	Recessed Rocker	04	M83504/02-024	76MRSB04S
Single Pole/Single Throw	Recessed Rocker	05	M83504/02-025	76MRSB05S
Single Pole/Single Throw	Recessed Rocker	06	M83504/02-026	76MRSB06S
Single Pole/Single Throw	Recessed Rocker	07	M83504/02-027	76MRSB07S
Single Pole/Single Throw	Recessed Rocker	08	M83504/02-028	76MRSB08S
Single Pole/Single Throw	Recessed Rocker	09	M83504/02-029	76MRSB09S
Single Pole/Single Throw	Recessed Rocker	10	M83504/02-030	76MRSB10S
Single Pole/Single Throw	Recessed Rocker	12	M83504/02-032	76MRSB12S
Single Pole/Single Throw	Slide	02	M83504/04-022	78M02S
Single Pole/Single Throw	Slide	03	M83504/04-023	78M03S
Single Pole/Single Throw	Slide	04	M83504/04-024	78M04S
Single Pole/Single Throw	Slide	05	M83504/04-025	78M05S
Single Pole/Single Throw	Slide	06	M83504/04-026	78M06S
Single Pole/Single Throw	Slide	07	M83504/04-027	78M07S
Single Pole/Single Throw	Slide	08	M83504/04-028	78M08S
Single Pole/Single Throw	Slide	09	M83504/04-029	78M09S
Single Pole/Single Throw	Slide	10	M83504/04-030	78M10S
Single Pole/Single Throw	Machine Insertable	02	M83504/12-002	90MB02S
Single Pole/Single Throw	Machine Insertable	03	M83504/12-003	90MB03S
Single Pole/Single Throw	Machine Insertable	04	M83504/12-004	90MB04S
Single Pole/Single Throw	Machine Insertable	05	M83504/12-005	90MB05S
Single Pole/Single Throw	Machine Insertable	06	M83504/12-006	90MB06S
Single Pole/Single Throw	Machine Insertable	07	M83504/12-007	90MB07S
Single Pole/Single Throw	Machine Insertable	08	M83504/12-008	90MB08S
Single Pole/Single Throw	Machine Insertable	09	M83504/12-009	90MB09S
Single Pole/Single Throw	Machine Insertable	10	M83504/12-010	90MB10S

Continued

MILITARY QUALIFIED DIP SWITCHES

ORDERING INFORMATION-CONTINUED

Circuitry	Description	Number of Positions	Military Part Number	Grayhill Part Number
Single Pole/Single Throw	Side Actuated	02	M83504/11-022	76MPSB02S
Single Pole/Single Throw	Side Actuated	03	M83504/11-023	76MPSB03S
Single Pole/Single Throw	Side Actuated	04	M83504/11-024	76MPSB04S
Single Pole/Single Throw	Side Actuated	05	M83504/11-025	76MPSB05S
Single Pole/Single Throw	Side Actuated	06	M83504/11-026	76MPSB06S
Single Pole/Single Throw	Side Actuated	07	M83504/11-027	76MPSB07S
Single Pole/Single Throw	Side Actuated	08	M83504/11-028	76MPSB08S
Single Pole/Single Throw	Side Actuated	09	M83504/11-029	76MPSB09S
Single Pole/Single Throw	Side Actuated	10	M83504/11-030	76MPSB10S
Single Pole/Single Throw	Side Actuated	12	M83504/11-032	76MPSB12S
Single Pole/Double Throw	Raised Rocker	02	M83504/05-022	76MSC02S
Single Pole/Double Throw	Raised Rocker	03	M83504/05-023	76MSC03S
Single Pole/Double Throw	Raised Rocker	04	M83504/05-024	76MSC04S
Single Pole/Double Throw	Recessed Rocker	02	M83504/06-022	76MRSC02S
Single Pole/Double Throw	Recessed Rocker	03	M83504/06-023	76MRSC03S
Single Pole/Double Throw	Recessed Rocker	04	M83504/06-024	76MRSC04S

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

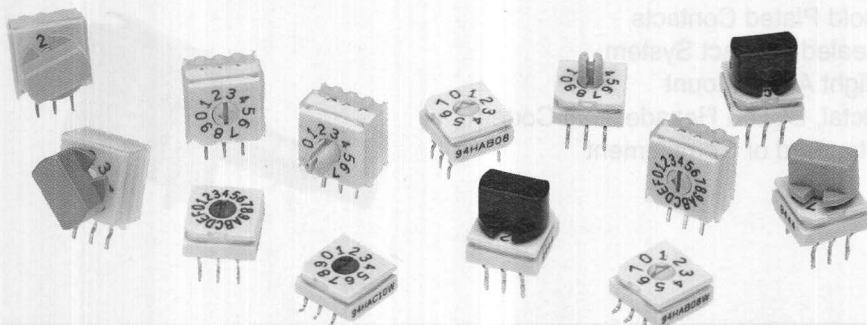
ADDITIONAL INFORMATION

For dimensions and number per packaging tube, see equivalent non-qualified styles, pages B-9 through B-15.

For Specifications, see page B-17.

BINARY CODED ROTARY DIP SWITCHES

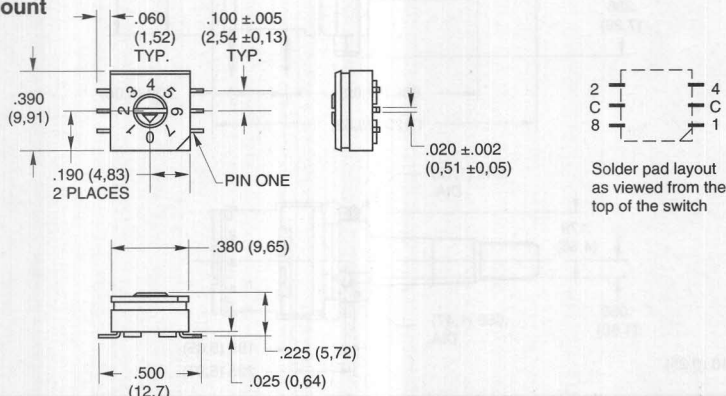
SERIES 94



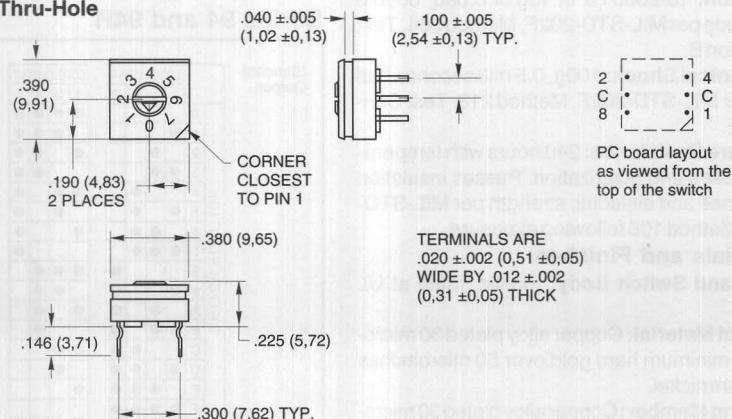
DIMENSIONS In inches (and millimeters)

Tolerances are $\pm .010$ inches unless specified otherwise.

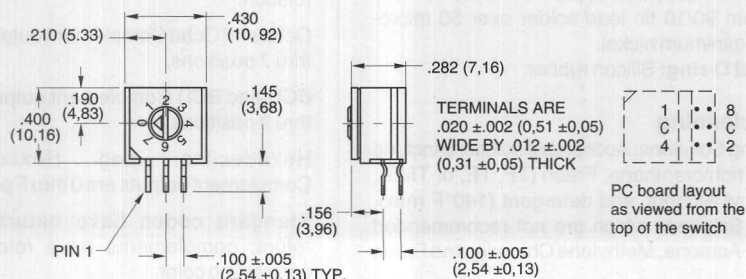
Surface Mount



Standard Thru-Hole



Right Angle Thru-Hole



FEATURES

- Sealed Construction; No Tape Seal Required
- Surface Mount or Thru-Hole Style
- Tube or Tape and Reel Packaging
- Octal, BCD, and Hexadecimal Code
- In Standard or Complement
- Standard and Right Angle Mount
- Flush or Extended Actuators
- Gold Plated Contacts

SWITCH MARKINGS



Octal-8 position



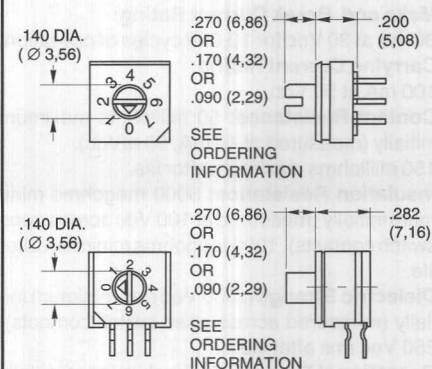
BCD-10 position



Hex-16 position

All actuation types are available in octal (8), binary coded decimal (10), or hexadecimal (16) codes; with either standard or complement output. Standard code outputs have natural color rotors; complements in a contrasting color.

EXTENDED ACTUATOR TYPES



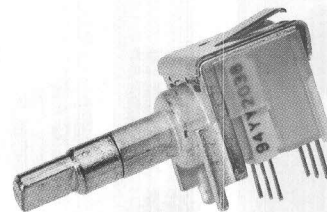
BINARY CODED ROTARY DIP SWITCHES

SERIES 94R

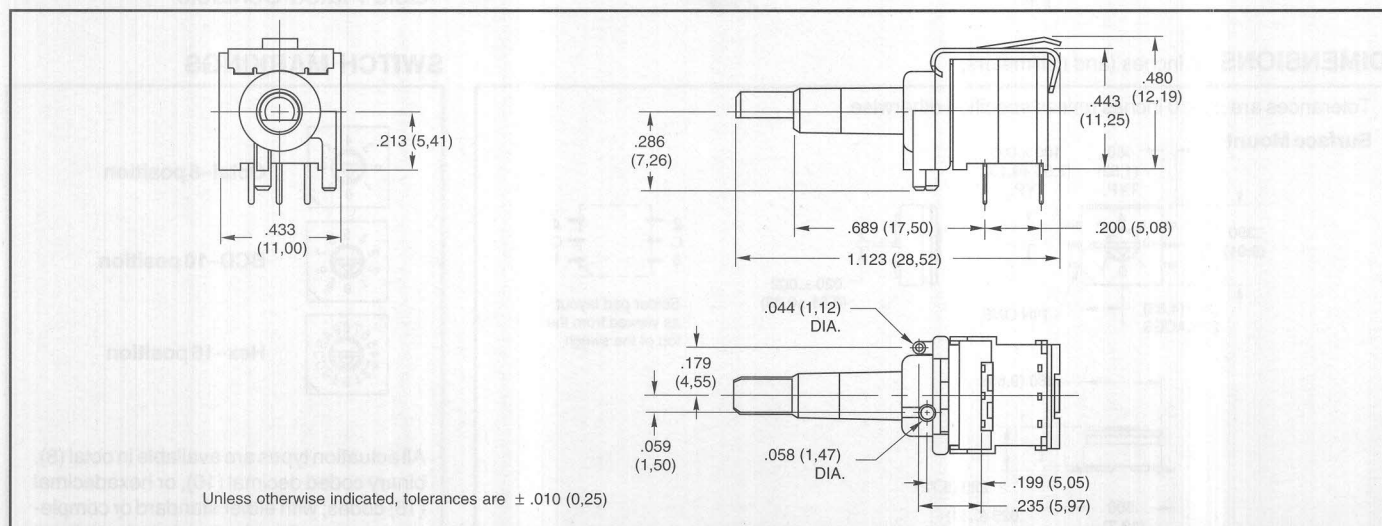
ECONOMICAL CODED OUTPUT ROTARY SWITCH

FEATURES

- 10,000 Cycles of Operation
- Gold Plated Contacts
- Sealed Contact System
- Right Angle Mount
- Octal, BCD & Hexadecimal Codes
- Standard or Complement



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS—Series 94 and 94R

Ratings

Mechanical Life: 10,000 cycles of operation. One cycle is a rotation through all positions and a complete return through all positions.

Make and Break Current Rating: 30 mA at 30 Vdc for 10,000 cycles of operation.

Carrying Current Rating:

100 mA at 50 Vdc.

Contact Resistance: 50 milliohms maximum initially (measured at 10 mA, 50 mVdc). 150 milliohms maximum after life.

Insulation Resistance: 5000 megohms minimum initially (measured at 100 Vdc across open switch contacts). 1000 megohms minimum after life.

Dielectric Strength: 500 Vac rms minimum initially (measured across open switch contacts). 250 Vac rms after life.

Operational Torque: 3 to 5 inch-ounces initially for a 16 position switch, 1.5 to 2.5 inch-ounces initially for an 8 or 10 position switch; and 1.2 inch-ounces minimum after life for all switches.

Environmental

Operating Temperature Range: -40 to +85° C.

Storage Temperature Range: -40° to +85° C.

Soldering Temperature: 250° C for 10 seconds maximum.

Vibration: 10-2000 Hz at 15g or 0.060" double amplitude per MIL-STD-202F, Method 204, Test Condition B.

Mechanical Shock: 100g, 0.5 milliseconds half sine per MIL-STD-202F, Method 213, Test Condition E.

Moisture Resistance: 240 hours with temperature cycling and polarization. Passes insulation resistance and dielectric strength per MIL-STD-202F, Method 106 following exposure.

Materials and Finishes

Rotor and Switch Body: Plastic, rated at UL 94V-0.

Contact Material: Copper alloy plated 30 microinches minimum hard gold over 50 microinches minimum nickel.

Shorting Member: Copper alloy plated 30 microinches minimum hard gold over 50 microinches minimum nickel.

Terminals: Copper alloy plated 100 microinches minimum 90/10 tin lead solder over 50 microinches minimum nickel.

Internal O-ring: Silicon rubber.

Flux cleaning

Cleaning Solutions: Acceptable solutions include 1-1-1 Trichlorethane, Freon (TF, TE, or TMS), Isopropyl Alcohol, and detergent (140°F maximum). Solutions which are not recommended include Acetone, Methylene Chloride, and Freon TMC.

CODE & TRUTH TABLES—Series 94 and 94R

Standard Output	CODE OUTPUT				CODE OUTPUT				Complement Output
	1	2	4	8	1	2	4	8	
0									
1	•				•				
2		•				•			
3	•	•			•	•			
4			•				•		
5	•		•		•		•		
6		•	•			•	•		
7	•	•	•		•	•	•		
8				•				•	
9	•			•	•			•	
A	•	•			•	•			
B		•	•			•	•		
C	•	•	•		•	•	•		
D		•		•		•		•	
E	•			•	•			•	
F	•	•	•	•	•	•	•	•	

Dot indicates terminal to common connection. All switches are continuous rotation.

Octal and Octal Complement outputs are 0 thru 7 positions.

BCD and BCD Complement outputs are 0 thru 9 positions.

Hexadecimal and Hexadecimal Complement outputs are 0 thru F positions.

Standard codes have natural color rotors; complements have rotors in a contrasting color.

BINARY CODED ROTARY DIP SWITCHES

SERIES 94 SWITCHES ORDERING INFORMATION—Tube Packaging

27 Pieces per Tube*

Type of Mounting	Actuator	Positions	Standard Code Part Number	Complement Code Part Number
Surface Mount	Flush	8, 10, 16	94HAB(08,10,16)W	94HAC(08,10,16)W
	0.09	8, 10, 16	94HEB(08,10,16)W	94HEC(08,10,16)W
	0.17	8, 10, 16	94HCB(08,10,16)W	94HCC(08,10,16)W
	0.27	8, 10, 16	94HBB(08,10,16)W	94HBC(08,10,16)W
Standard Thru-Hole	Flush	8, 10, 16	94HAB(08,10,16)	94HAC(08,10,16)
	0.09	8, 10, 16	94HEB(08,10,16)	94HEC(08,10,16)
	0.17	8, 10, 16	94HCB(08,10,16)	94HCC(08,10,16)
	0.27	8, 10, 16	94HBB(08,10,16)	94HBC(08,10,16)
Right Angle Thru-Hole	Flush	8, 10, 16	94HAB(08,10,16)RA	94HAC(08,10,16)RA
	0.09	8, 10, 16	94HEB(08,10,16)RA	94HEC(08,10,16)RA
	0.17	8, 10, 16	94HCB(08,10,16)RA	94HCC(08,10,16)RA
	0.27	8, 10, 16	94HBB(08,10,16)RA	94HBC(08,10,16)RA

*Surface mount and perpendicular, 24 pieces per tube for right angle switches.

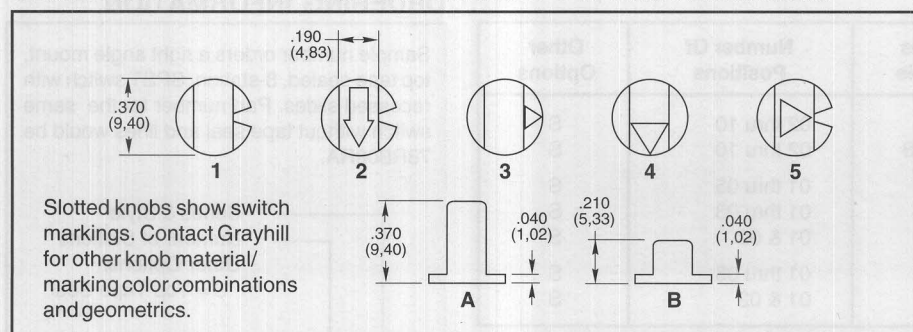
ORDERING INFORMATION—Tape and Reel Packaging

Type	Code and Positions	Binary (B) Complement (C)	Part Number Tape and Reel	Part Number 25 Pc. Test Reel
Surface Mount	OCT 8	B	94HAB08WR	94YY2130
	BCD 10	B	94HAB10WR	94YY2131
	HEX 16	B	94HAB16WR	94YY2132
	OCT 8	C	94HAC08WR	94YY2133
	BCD 10	C	94HAC10WR	94YY2134
	HEX 16	C	94HAC16WR	94YY2135

SERIES 94R SWITCHES ORDERING INFORMATION

Code	No. of Positions	Standard Code Part Number	Complement Part Number
Octal	8	94RB08C	94RC08C
BCD	10	94RB10C	94RC10C
Hexadecimal	16	94RB16C	94RC16C

SERIES 94 HIGH TEMPERATURE KNOBS—For Shaft Extensions

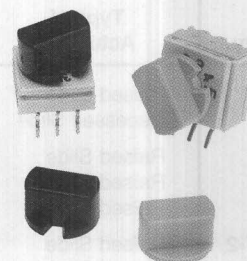
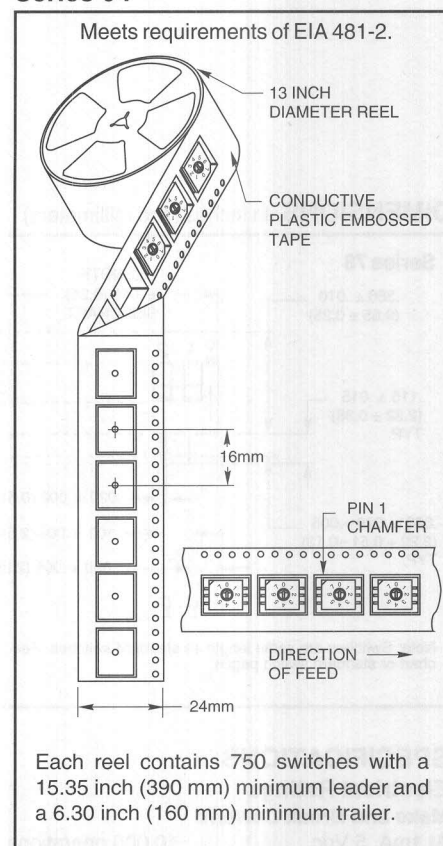


ORDERING INFORMATION—Series 94 High Temperature Knobs*

Knob Style and Height	Knob Color	Arrow Color	Part Number
1A	Gray	N/A	947706-001
5A	Gray	Black	947706-003
1B	Black	N/A	947705-001
1B	Gray	N/A	947705-012
2B	Gray	White	947705-004
3B	Gray	Black	947705-017
4B	Gray	Black	947705-018
1B	Natural	N/A	947705-009
4B	Black	White	947705-010
5B	Gray	Black	947705-019

*Ordered as a separate item.

TAPE AND REEL PACKAGING—Series 94



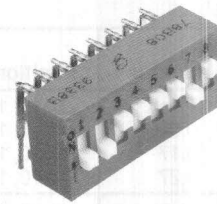
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill. Prices anticipate take-up reel return to Grayhill.

RIGHT ANGLE DIP SWITCH OPTION

SERIES 78

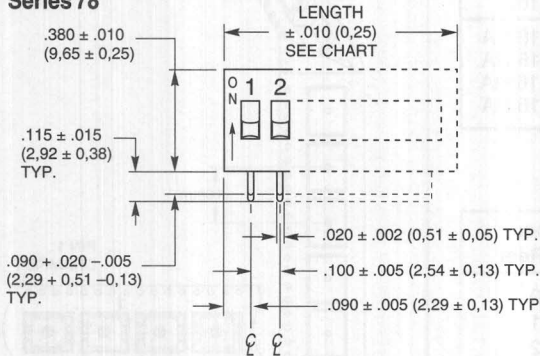
FEATURES

- Easy Access
- SPST Circuitry



DIMENSIONS In inches (and millimeters)

Series 78



Note: Switches are same length as standard switches. See chart or standard switch pages.

Note: Terminal row spacing is designed to be used in PC board holes with .100 X .100 (2,54 x 2,54) centers.

SPST Switch Length

NO. OF STATIONS	LENGTH INCHES	LENGTH MILLIMETERS
2	0.280	7,1 MM
3	0.380	9,7 MM
4	0.480	12,2 MM
5	0.580	14,7 MM
6	0.680	17,3 MM
7	0.780	19,8 MM
8	0.880	22,4 MM
9	0.980	24,9 MM
10	1.080	27,4 MM
12	1.280	32,5 MM

The 12 station length is for Series 76 switches. For switches of circuitry other than SPST, see standard switch pages.

SPECIFICATIONS

Electrical Ratings

Make and Break Current:

At 1mA, 5 Vdc	10,000 operations
At 50 or 125 mA, 30 Vdc	10,000 operations

Materials and Finishes

Terminal Ends: Copper alloy, solder (90/10) plated 150 microinches minimum over copper/nickel barrier

For other specifications, see Additional Information.

ADDITIONAL INFORMATION

For SPST switches, see page B-14.

For Multipole/ST switches see page B-14.

For SPDT switches, see page B-15; and for DPDT switches, see page B-16.

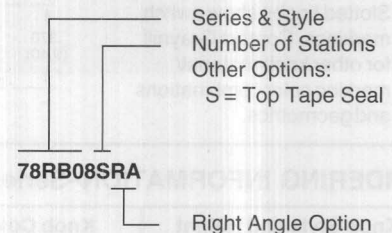
For additional specifications, see page B-17.

CHOICES

Circuitry	Type of Actuation	Series & Style	Number Of Positions	Other Options
SPST	Raised Slide	78B	02 thru 10	S
SPST	Recessed Slide	78RB	02 thru 10	S
2PST	Raised Slide	78F	01 thru 05	S
3PST	Raised Slide	78G	01 thru 03	S
4PST	Raised Slide	78H	01 & 02	S
SPDT-2	Raised Slide	78J	01 thru 05	S
DPDT-4	Raised Slide	78K	01 & 02	S

ORDERING INFORMATION

Sample number orders a right angle mount, top tape sealed, 8-station, SPST switch with recessed slides. Part number for the same switch without tape seal and lines would be 78RB08RA.



Available from your local Grayhill Distributor
Priced competitively. For price, contact Grayhill.

DIP SWITCH OPTIONS AND ACCESSORIES

OPTIONS

Position Identification Line Option

For Series 76RSB, 76RSC, 76RSD, & 90B

A line can be added to the recessed rocker or Series 90 slide actuator to provide positive identification of the actuator position. To order, add L as a final suffix to the part number. For example, 76RSB08 becomes 76RSB08L; and, 90B08S becomes 90B08SL.

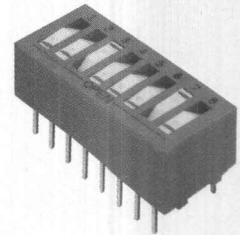
Available from a local Grayhill Distributor

Other Switch Marking

For Series 76, 78, & 90

We can mark your part number or other wording on the switch, often at no charge. For some markings there will be a nominal charge for tooling plus a set-up charge. In addition, there is a marking charge per side per switch. Add it to the unit price and discount it accordingly.

To order, contact Grayhill.



ACCESSORIES

Protective Cover Accessory

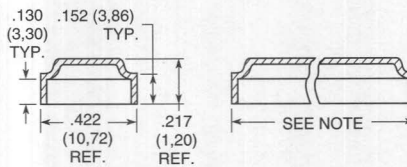
For Series 76, & 78

Rigid, clear plastic cover fits all but toggle actuated switches. It provides a top cover for less strenuous cleaning, serves as a dust cover in dirty environments, and provides protection against accidental actuation.

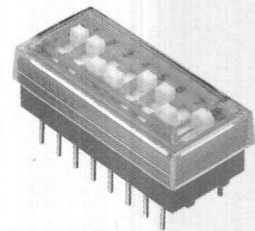
Material: 76,78, only-Polycarbonate.

Purchase as a separate item. Check length of the desired DIP Switch, and then select from the ordering information on this page.

Available from a local Grayhill Distributor



Note: For length, add .042" (1,07 MM) to length of DIP switch.



DIPSTICK Accessory

For all series

Pen sized plastic DIPSTICK has a tapered end for actuating DIP Switches.

Part Number 90-DIPSTICK

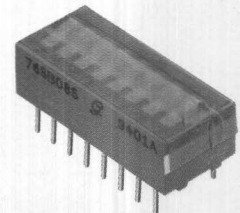
Available from a local Grayhill Distributor

User Applied Tape Seals

For Series 76 & 78

If you prefer to seal switches after your incoming inspection, order a card of 23 (or 46) tape seals. Hand application of these tapes provides less secure seal integrity than factory addition of seals. Check the length of the desired DIP Switch, then select the card of tapes from the chart below.

Available from a local Grayhill Distributor



ORDERING INFORMATION

Length Inches	Tape Seals Part Number	No./ Card
0.280	SHH1127-2	46
0.380	SHH1127-3	46
0.480	SHH1127-4	46
0.580	SHH1127-5	23
0.680	SHH1127-6	23
0.780	SHH1127-7	23
0.880	SHH1127-8	23
0.980	SHH1127-9	23
1.080	SHH1127-10	23

Length Inches	Protective Cover Part Number
0.280	76P02
0.380	76P03
0.480	76P04
0.580	76P05
0.680	76P06
0.780	76P07
0.880	76P08
0.980	76P09
1.080	76P10
1.180	79P10
1.780	79P16

Available from your local Grayhill Distributor
Priced competitively. For price, contact Grayhill.



KEYBOARDS

- Keypads and Modular Types
- Audible/Tactile Snap
- Standard, Prototype Style, Or Custom Legending
- Choice of Button Distances
- Buttons or Color Graphics

Page

SELECTION C-3

STANDARD KEYPAD FORMATS

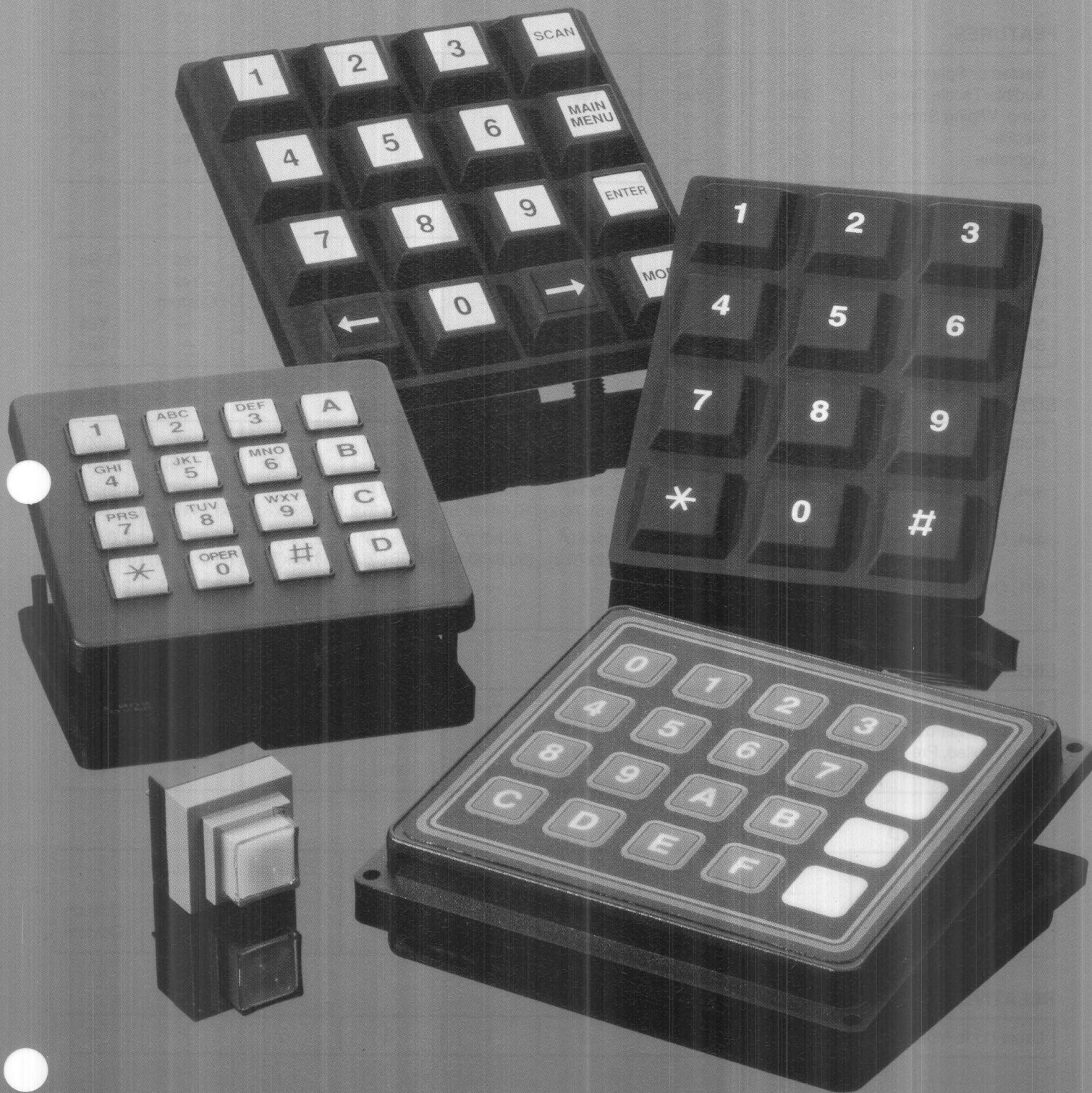
Conductive Rubber Keypads	Series 96	C-4
Environmentally Sealed Keypads	Series 84S & 84LS	C-8
Unsealed 12, 16, and 20 Button Keypads	Series 83, 84, & 86	C-16
Sealed, Flange Mounted, Keypads	Series 88	C-28

MODULAR KEYBOARDS

Long Stroke, Wiping Contact, Lightable	Series 82	C-34
Low Profile, Snap Dome	Series 87	C-40

CUSTOM KEYBOARDS

Custom Designed Keyboards	C-45
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SELECTOR CHARTS

SELECTION CRITERIA Pages	KEYPAD SERIES						MODULAR SERIES	
	96	84S/84LS	84	83	86	88	82	87
	C-4 to C-7	C-8 to C-15	C-16 to C-19	C-20 to C-23	C-24 to C-27	C-28 to C-33	C-34 to C-39	C-40 to C-44

FEATURES

Sealed or Splashproof	—	Yes	—	—	—	Yes	—	—
Audible/Tactile Snap	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
Long, Wiping Stroke	—	—	—	—	—	—	Yes	—
Modular	—	—	—	—	—	—	Yes	Yes
Lightable	—	—	—	—	—	—	Yes	—

CIRCUITRY

SP/Single Throw	—	—	—	—	—	—	Yes	(1-Btn)
2PST to 4PST & Coded	—	—	—	—	—	—	Yes	—
Variable, Per Button	—	—	—	—	—	—	Custom	—
Matrix; XY; Row & Clmn.	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes
SP/Common Bus	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes

SIZE In Inches (and millimeters)

Button Center Distances	.500 (12,7)	.750 (19,05)	.750 (19,05)	.500 (12,7)	.500 (12,7)	.500 (12,7)	.687 (17,45)	.500 (12,7)
3x4, Outer Dimensions	2.0x2.7" (50,8x68,58)	2.4x3.1" (60,96x78,74)	2.3x3.0" (58,42x76,2)	1.6x2.0" (40,64x50,8)	2.2x3.0" (55,88x76,2)	2.2x3.0" (55,88x76,2)	2.1x3.0" (53,34x76,2)	1.5x2.0" (38,1x50,8)
4x4, Outer Dimensions	2.5x2.7" (63,5x68,58)	3.1x3.1" (78,74x78,74)	3.0x3.0" (76,2x76,2)	2.0x2.0" (50,8x50,8)	2.7x3.0" (68,58x76,2)	2.7x3.0" (68,58x76,2)	3.0x3.0" (76,2x76,2)	2.0x2.0" (50,8x50,8)
5x4, Outer Dimensions	—	—	—	—	3.2x3.0" (81,28x76,2)	3.2x3.0" (81,28x76,2)	3.7x3.0" (93,98x76,2)	2.5x2.0" (63,5x50,8)

LEGENDING

Telephone	Yes	Yes	Yes	Yes	Yes	Yes	Yes	—
Other Standards	Yes	Yes	Yes	Yes	Yes	Yes	—	—
User Applied, Pre-Printed	—	—	Yes	Yes	Yes	Yes	Yes	Yes
Custom	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

LEGEND METHOD

Deadfront and Thru-Lit	—	—	—	—	—	Custom	Yes	—
Graphics, Color	—	—	—	—	—	Yes	—	—
Plastic, Molded-In	—	Custom	Yes	Yes	Custom	—	Yes	Custom
Printed, Epoxy Ink	Yes	Yes	Custom	Custom	Yes	—	Custom	Custom

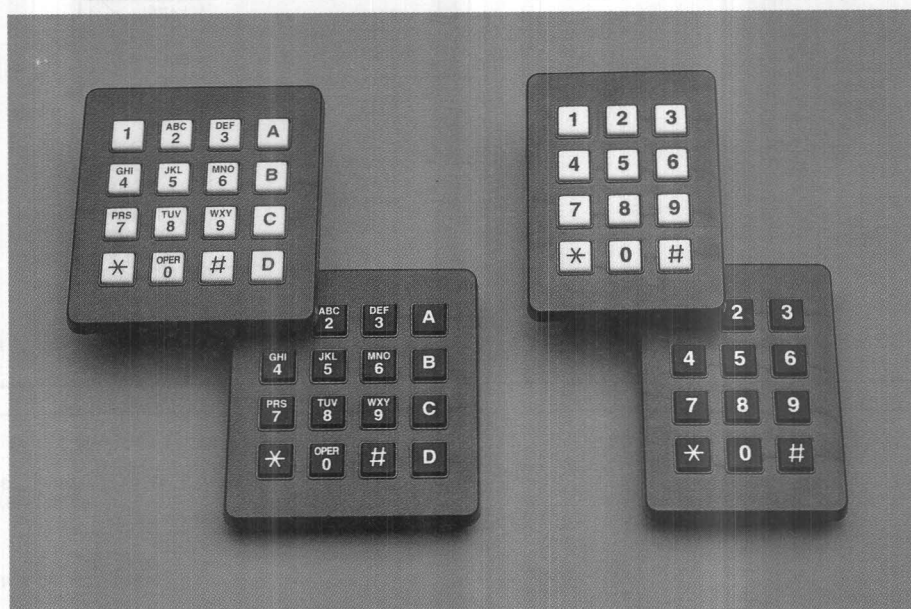
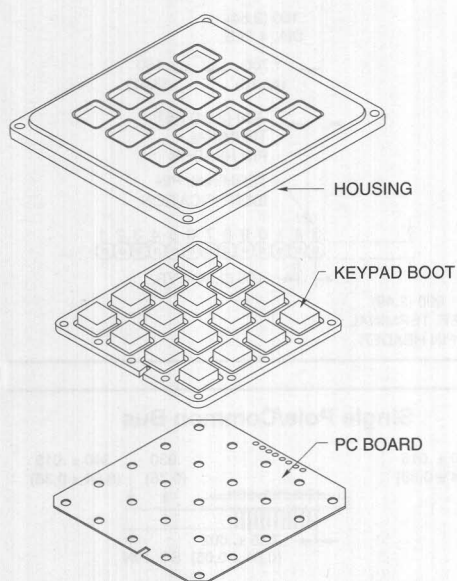
RELATIVE PRICE

Least (1) to Most (8)	1	8	4	2	3	6	7	5
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SERIES 96

FEATURES

- Quality, Economical Keyboards
- Easily Customized Legends
- Termination Mates With Standard Connectors
- Tactile Feedback to Operator
- 3,000,000 Operations per Button
- Compatible With High Resistance Logic Inputs

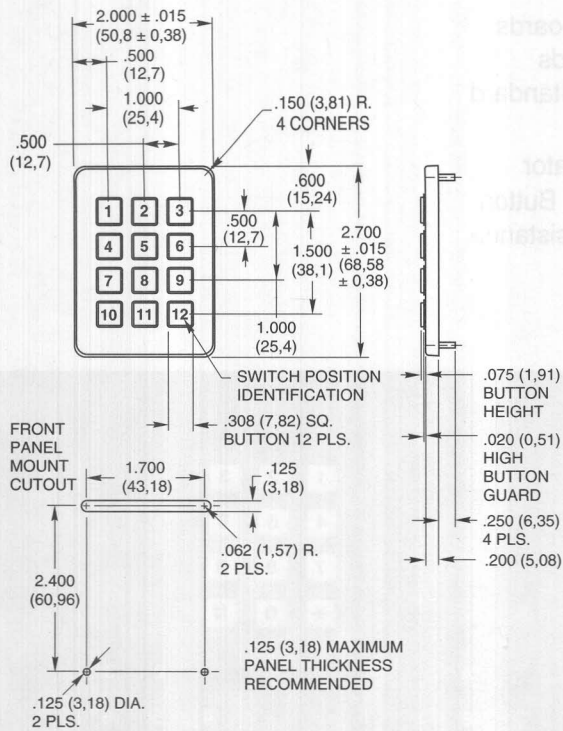


The Series 96 is Grayhill's most economical 3x4 and 4x4 keypad family. The contact system utilizes conductive rubber to mate the appropriate PC board traces. Matrix and single pole/common bus circuitry is offered. Built with quality component parts. The Series 96 is subjected to our rigid statistical process control to insure that it meets our reliability standards.

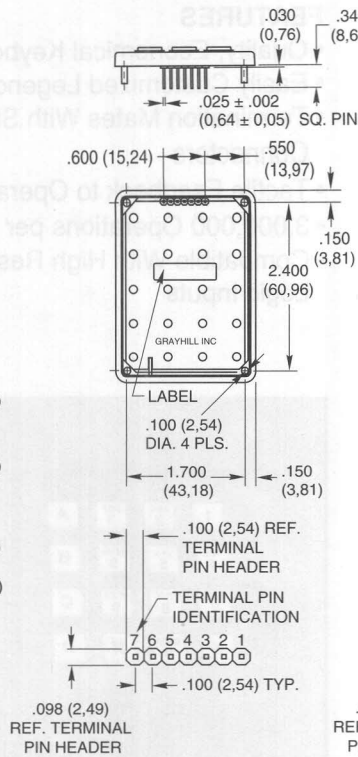
CONDUCTIVE RUBBER KEYPADS

DIMENSIONS In inches (and millimeters)

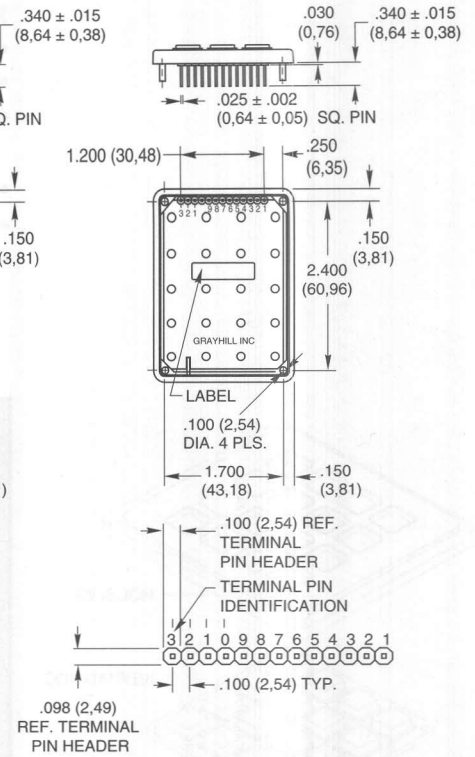
3x4 Front Mount Keyboard



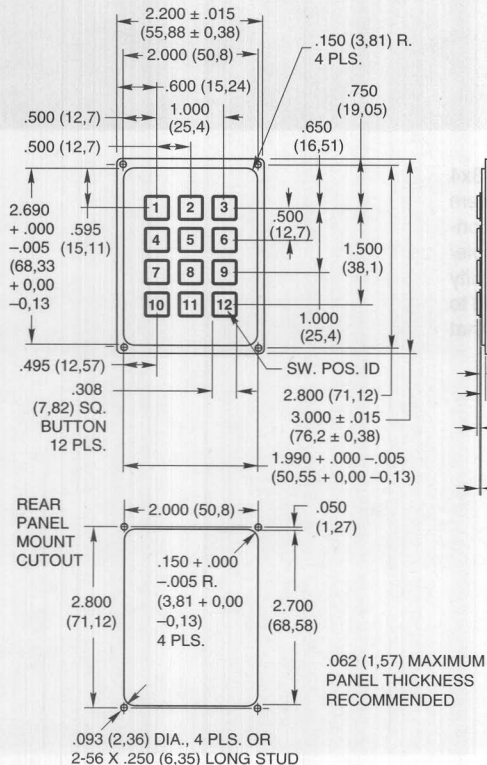
Matrix Output



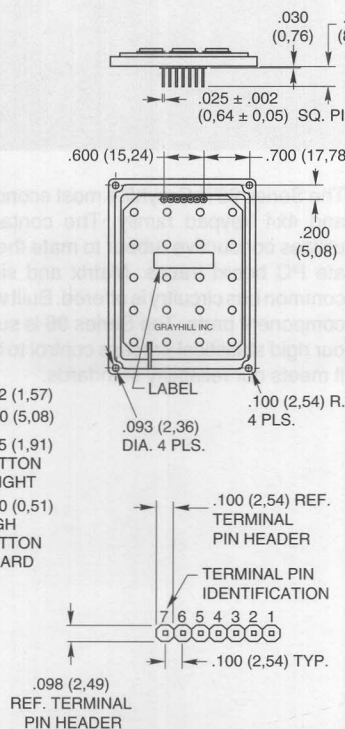
Single Pole/Common Bus



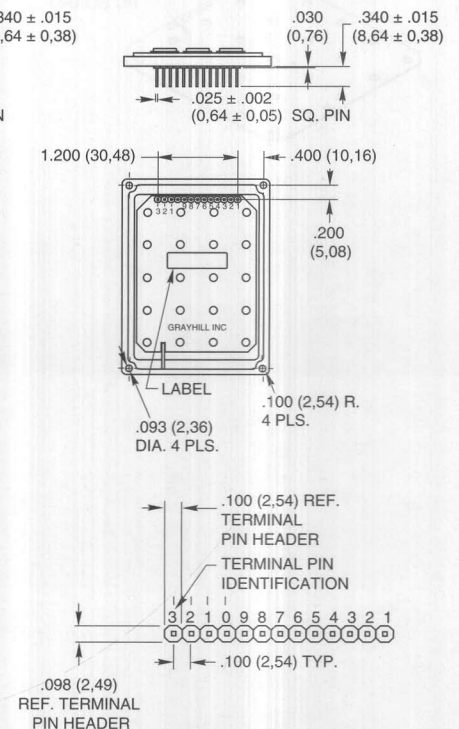
3x4 Rear Mount Keyboard



Matrix Output



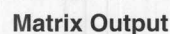
Single Pole/Common Bus



See page C-7 for code and truth tables, specifications, standard legends and ordering information.

DIMENSIONS In inches (and millimeters)

4x4 Front Mount Keyboard

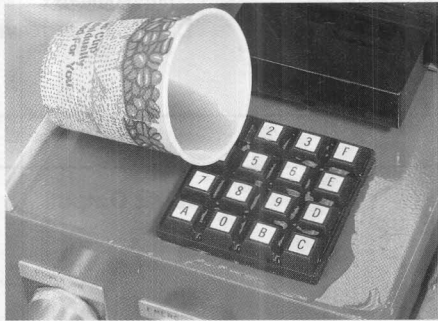
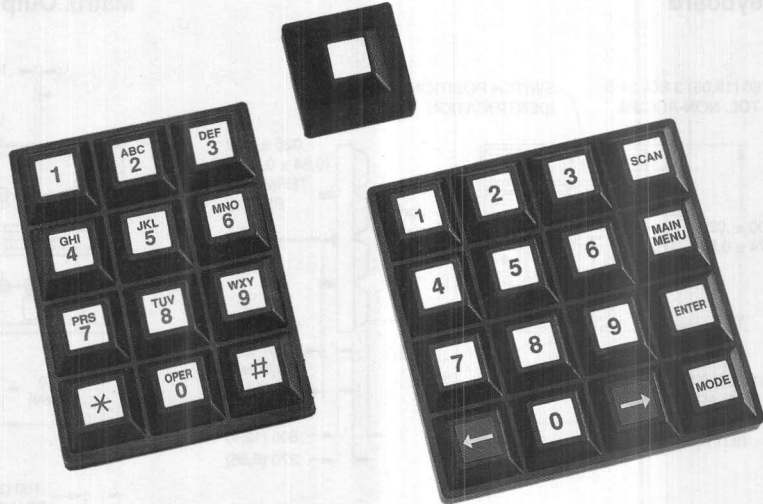


ENVIRONMENTALLY SEALED KEYBOARDS

SERIES 84S

FEATURES

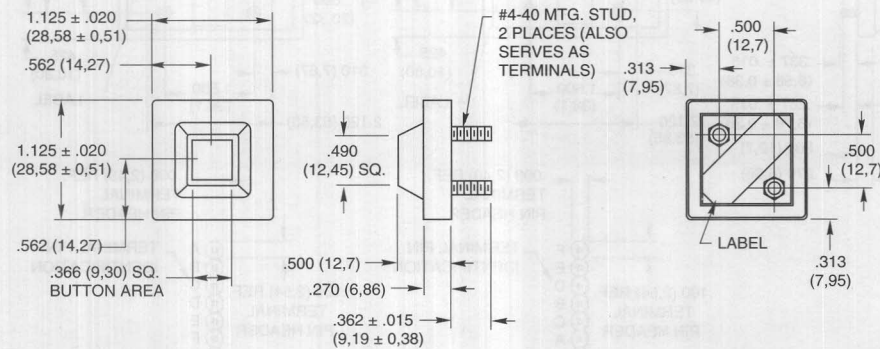
- Waterproof Silicone Rubber
- Easily Customized Legends
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button



The 3x4 and 4x4 keyboards have matrix (row and column) and single pole/common bus circuitry. A one-piece boot completely seals the contact system and the keypad to the panel. The boot is made of military grade silicone rubber. The keyboard is rated for 3 million operations per button. Optional EMI shielding retains the integrity of equipment to external interference. Buttons are located on $\frac{3}{4}$ " centers and are interchangeable. Any legend can be printed at a nominal cost.

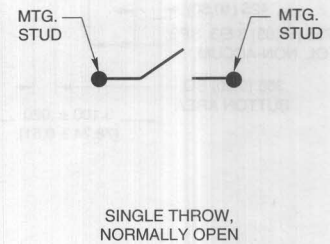
DIMENSIONS In inches (and millimeters)

1 Button Module



Unless otherwise noted, linear dimension tolerances are $\pm .010$ (0,25)

CIRCUITRY

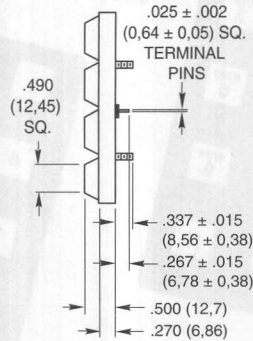
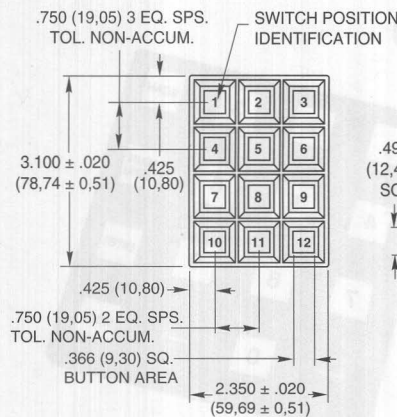


Note: Mounting studs serve as terminals.

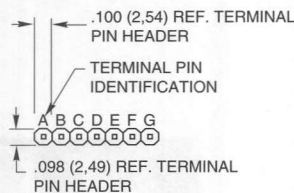
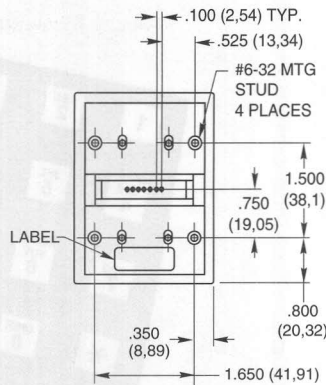
ENVIRONMENTALLY SEALED KEYBOARDS

DIMENSIONS In inches (and millimeters)

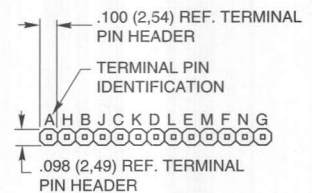
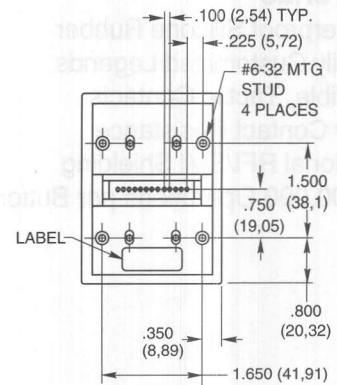
3x4 Keyboard



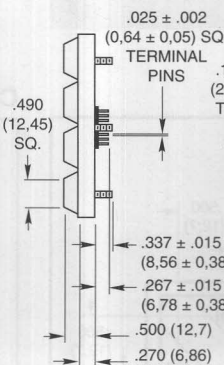
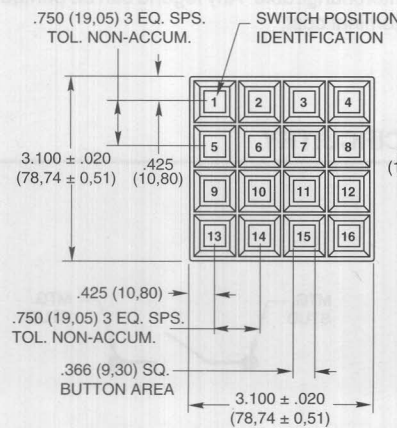
Matrix Output



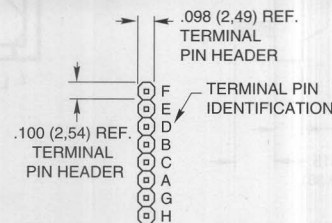
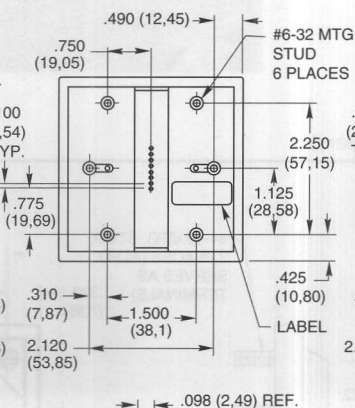
Single Pole/Common Bus



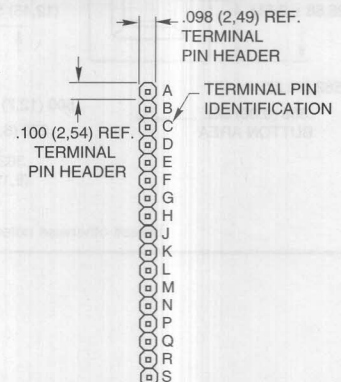
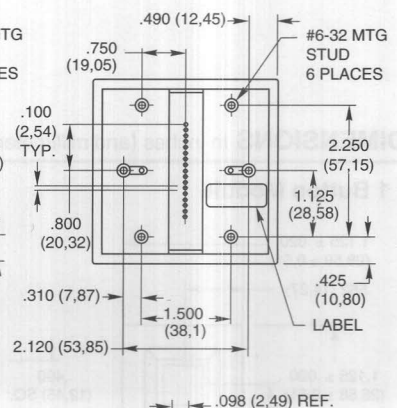
4x4 Keyboard



Matrix Output



Single Pole/Common Bus



CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed.
Terminals are identified on the keyboard.

12 Button Keypads

3x4	CODES											
	Matrix						Single Pole/Common Bus					
BUTTON LOCATION	1	•		•			•					•
2		•										•
3			•									•
4	•			•								•
5		•										•
6			•									•
7	•											•
8		•										•
9			•									•
10	•											•
11		•										•
12			•									•
	C	B	A	G	F	E	D	E	C	B	F	D
	TERMINAL LOCATION											

16 Button Keypads

4x4	CODES															
	Matrix								Single Pole/Common Bus							
BUTTON LOCATION	1	•							•							•
2		•														•
3			•													•
4	•			•												•
5		•														•
6			•													•
7	•															•
8		•														•
9			•													•
10	•															•
11		•														•
12			•													•
13	•															•
14		•														•
15			•													•
16	•															•
	A	B	C	D	E	F	G	H	D	B	A	C	H	F	E	G
	TERMINAL LOCATION															

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: ≤10 milliamps resistive
Contact Bounce: 4 milliseconds maximum at make; 10 milliseconds, at break
Contact Resistance: MOS, TTL, and DTL compatible. (10 ohms maximum)
Life Expectancy: 3 million operations/button
Insulation Resistance: ≥1,000 megohms

Operating Features

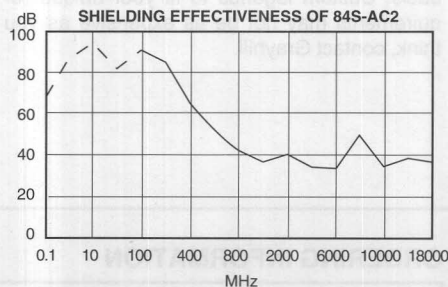
Pre-Travel: .030 inches minimum
Operating Force: 20 ± 4 ounces
Humidity: 0 to 98% (no condensation)
Minimum Push Out Force Per Pin: 5 pounds

Materials and Finishes

Terminal Pins: Copper alloy CDA 725, solder plated
PC Board: FR-4 glass cloth epoxy
Contact Dome: Stainless steel, selectively gold plated
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Phosphor bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone rubber
Buttons: ABS Cycolac, grade KJB

Shielding Effectiveness

Results shown are typical for a standard GRAYHILL Series 84S Keyboard. A conductive gasket will generally increase the shielding, depending on the size and shape of the gasket and its material. Data derived for E-Field Radiation.



— — Represents shielding effectiveness greater than or equal to line.

Frequency M Hz	Rating in dB
0.1	≥ 66.2
10	≥ 94.8
100	90.5
400	64.2
800	42.3
2,000	40.5
6,000	33.1
10,000	34.4
18,000	37.0

Test Method:

Measurements were made with the keyboard mounted to a brass plate, which in turn was mounted to a shielded enclosure containing the receiving equipment. A signal generator provided the frequency source that was radiated from the transmitting antenna to the enclosed receiving antenna. The spacing between antennas was maintained constant throughout the frequency range. The effectiveness rating is determined by establishing a reference reading without obstruction between the two antennas and determining the difference between that reading and the test setup reading.

Note:

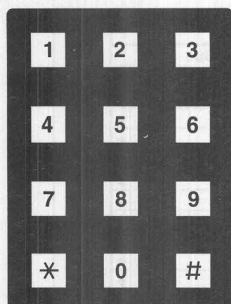
When measured in actual equipment, shielding effectiveness is determined by many factors. This method accurately represents the shielding effectiveness of the GRAYHILL Series 84S under ideal test conditions.

ENVIRONMENTALLY SEALED KEYBOARDS

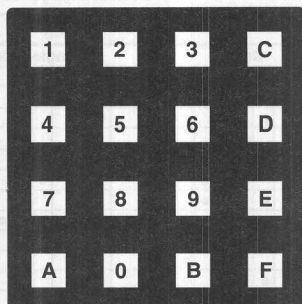
STANDARD LEGENDS

Available through Grayhill Distributors

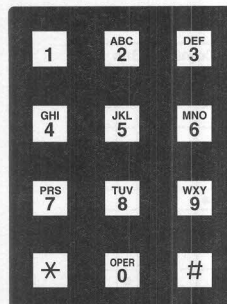
To order one of the configurations below, use the dash number shown here; select the keypad size and code, and order the part number with the appropriate legend dash number. The buttons in these keypads can be removed, and reinserted in any configuration.



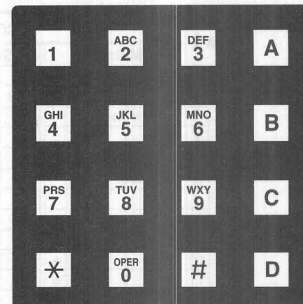
-112



-014

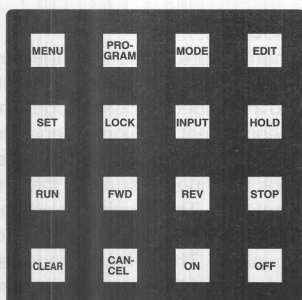


-113



-016

CUSTOM LEGENDS

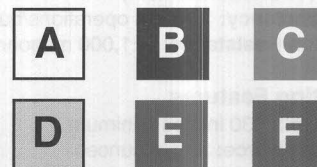


Library of Legends

Grayhill maintains a legend library which contains the most often requested special legends and many unusual ones. If the legend is in the library, the cost to utilize this legend in your keypad configuration is minimal. If the legend is not available, Grayhill can list the charges required to add your legend to the library. In this manner, new legends are added on a periodic basis. Custom legends to fit your unique requirements may not be as expensive as you think, contact Grayhill.

Adding Color

Use colored buttons to segregate button groupings or to provide originality. Available in black legends on white or yellow buttons, or in white legends on black, green, red or blue buttons. Two popular combinations, black on white and white on black, are available from Grayhill stock. Delivery time will increase for other color combinations.

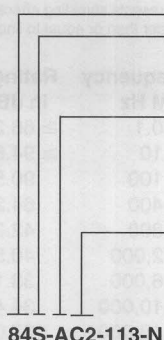


HEADER CONNECTORS

Compatible with:

Samtec, Inc. Header Series BCS, BSW, CES, ESW, ESQ, SLW, SSW, SSQ, IDSS and IDSD or equivalent.

ORDERING INFORMATION



Grayhill Series Number

Shielded or Non-Shielded Option

S = Shielded

SN = Non-Shielded

Size Option

A = 3x4

B = 4x4

C = 1 Button

Circuitry Option (B2 and C2 not applicable to 1 button)

B2 = Matrix in-line pins

C2 = Single pole/common bus, in-line pins

C3 = 1 Button, SPST-N.O., non-shielded only

Mounting Nut Option

N = Provided with assembled stud nuts

Blank = Nuts not provided

Standard Legend Choices

3x4 Size: -112 or -113

4x4 Size: -014 or -016

1 Button: -001, No legend, white button

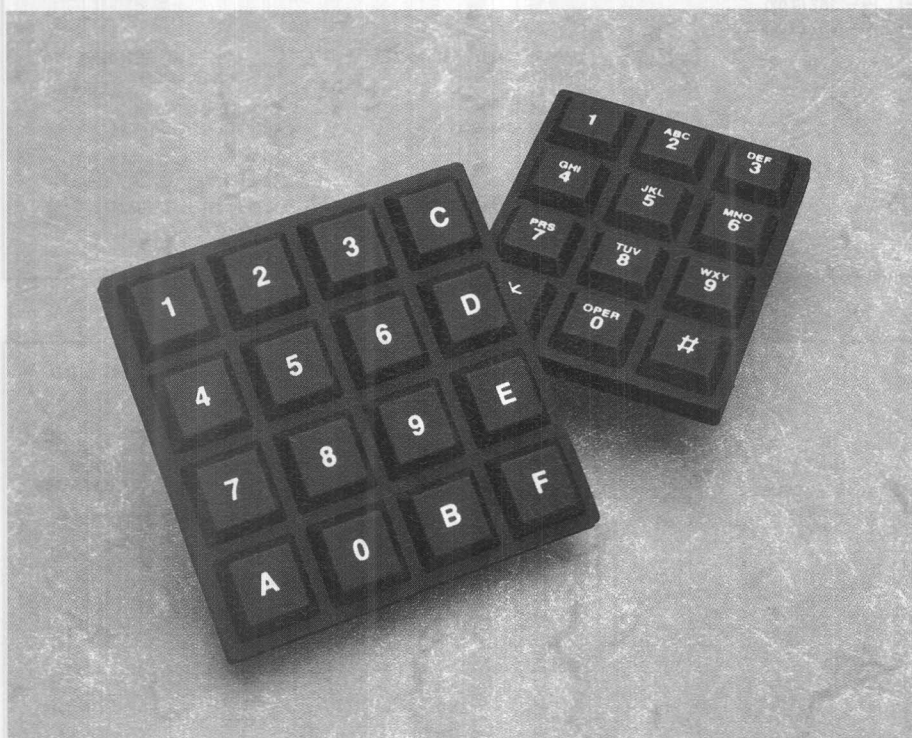
Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 84LS

KEYBOARD FEATURES

- Low Profile
- Waterproof Silicone Rubber
- Easily Customized Legends
- Audible, Tactile Contacts
- Low Contact Resistance
- Optional RFI/EMI Shielding
- 3,000,000 Operations per Button



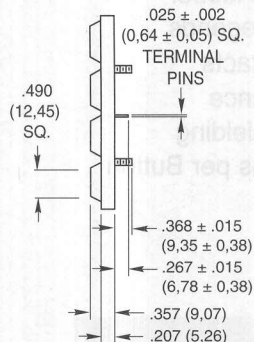
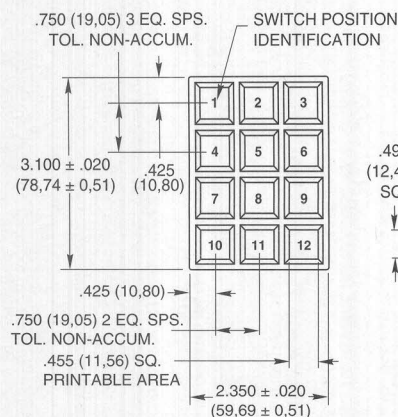
DESCRIPTION

The Series 84LS is the low profile version of GRAYHILL's popular Series 84S sealed keypads. These keypads are legended by epoxy ink printing the rubber key tops. Custom legends and colors are available at a nominal cost. The Series 84LS is offered with a choice of matrix or single pole/common bus circuitries, and EMI shielding.

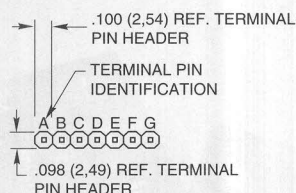
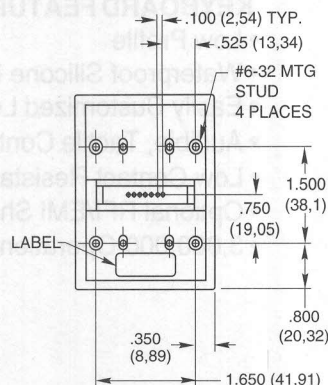
ENVIRONMENTALLY SEALED KEYBOARDS

DIMENSIONS In inches (and millimeters)

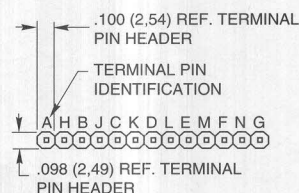
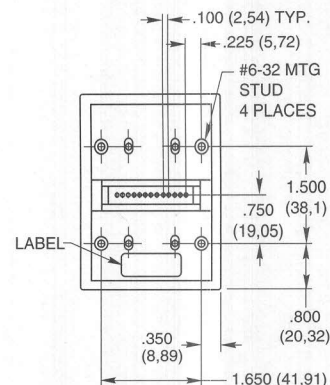
3x4 Keyboard



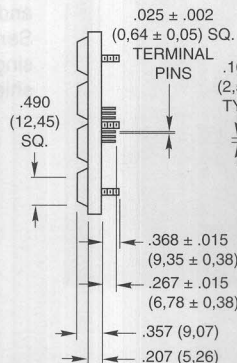
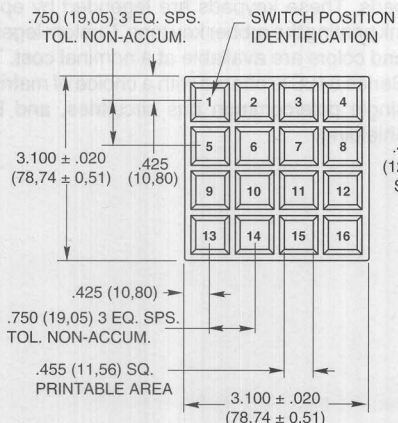
Matrix Output



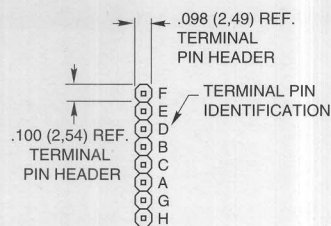
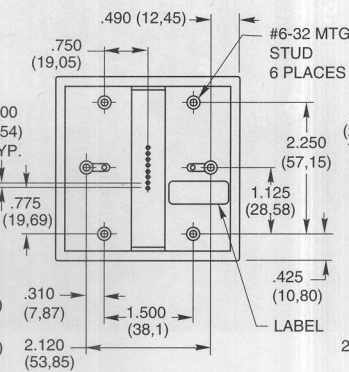
Single Pole/Common Bus



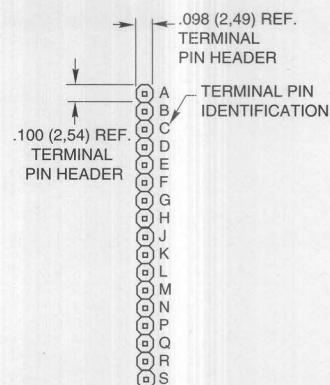
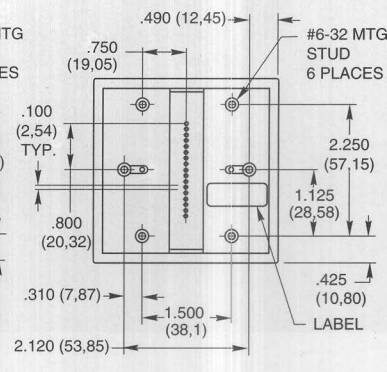
4x4 Keyboard



Matrix Output



Single Pole/Common Bus



12 Button Keypads

3x4		CODES																			
		Matrix						Single Pole/Common Bus													
BUTTON LOCATION	1	•			•				•								•				
	2		•							•							•				
	3					•											•				
	4	•															•				
	5		•								•						•				
	6			•				•									•				
	7																•				
	8	•															•				
	9		•														•				
	10																•				
	11		•														•				
	12			•													•				
		C	B	A	G	F	E	D	E	C	B	F	D	A	N	K	H	M	L	J	G
		TERMINAL LOCATION																			

16 Button Keypads

[illegible]

PC Board: FR-4 glass cloth epoxy
Dome Retainer/Rear Seal Sheet: Polyester
Mounting Studs: Phosphor Bronze
Optional Hex Nut: Stainless steel, passivated
Optional EMI Shield: Aluminum foil
Keypad: Silicone Rubber

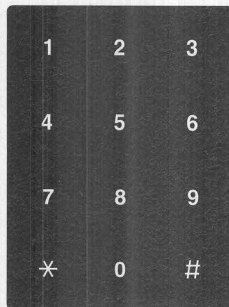
C-14

ENVIRONMENTALLY SEALED KEYBOARDS

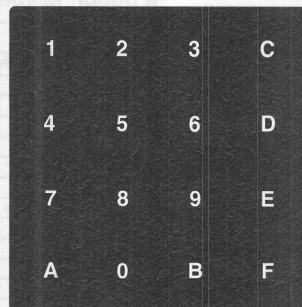
STANDARD LEGENDS

Available through Grayhill Distributors

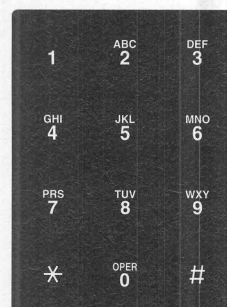
To order one of the configurations below, use the dash number shown here; select the keypad size and code, and order the part number with the appropriate legend dash number.



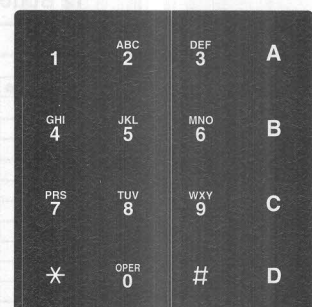
-112



-014



-113



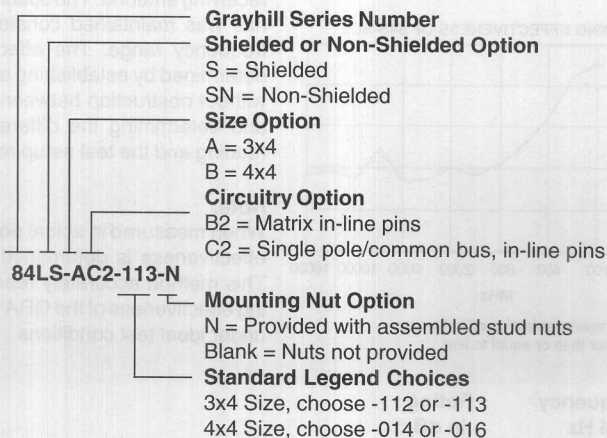
-016

CUSTOM LEGENDS

Any reasonable legend can be printed in the key area. Fax a sketch of your requirements to GRAYHILL. Printing and symbols will be coordinated in keeping with concepts of good design. Or, if required, the details of your submitted

artwork will be matched as closely as possible. Allow 3 to 4 weeks for custom legend delivery. A nominal charge, depending on the total quantity of keypads ordered and the complexity of the legend, will be assessed.

ORDERING INFORMATION



HEADER CONNECTORS

Compatible with:

Samtec, Inc. Header Series BCS, BSW, CES, ESW, ESQ, SLW, SSW, SSQ, IDSS and IDSD or equivalent.

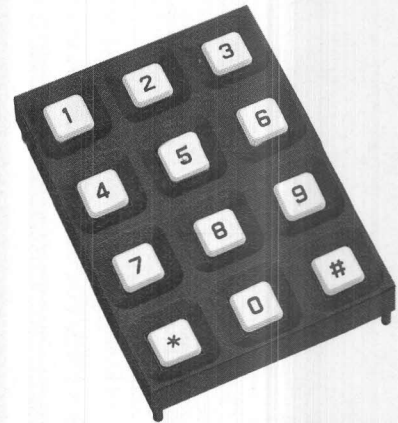
Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

SERIES 84

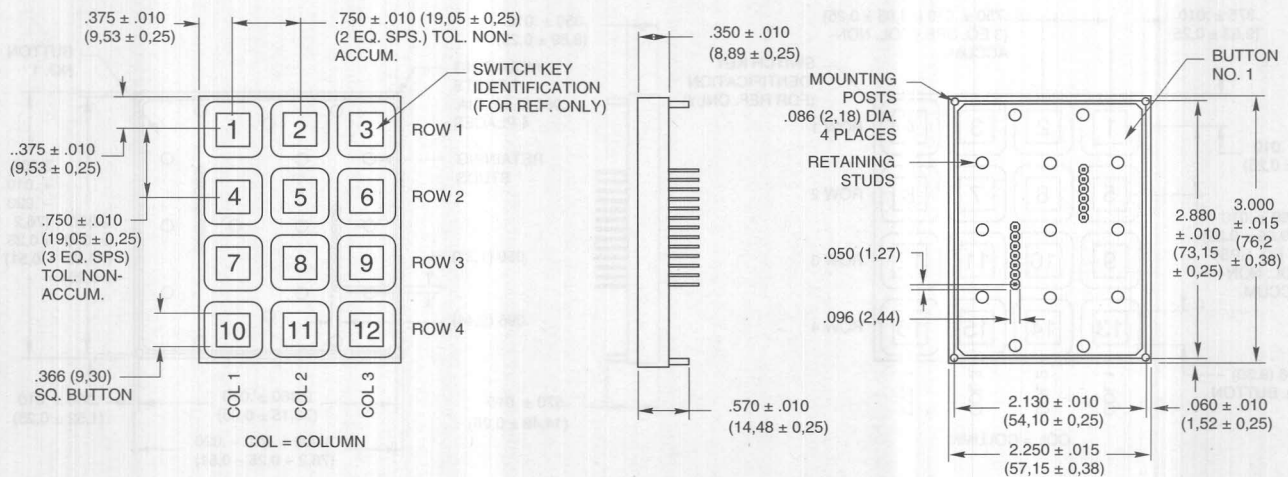
FEATURES

- 3/4" Button Centers
- Post Mounted
- Mounts by Tinnerman Nut or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback



DIMENSIONS In inches (and millimeters)

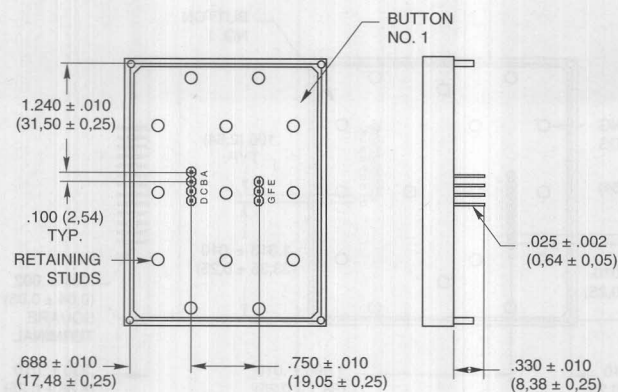
3x4 Keyboard



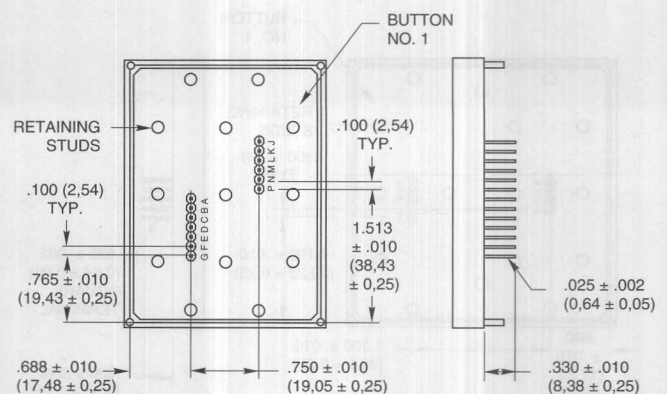
Termination In inches (and millimeters)

3x4

Matrix Output



Single Pole/Common Bus



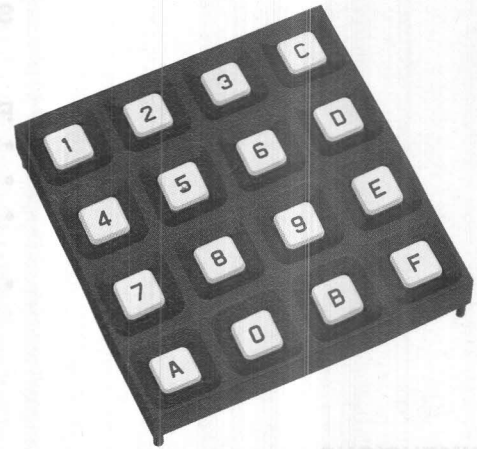
See pages C-18 and C-19 for code and truth tables, specifications, legends and ordering information.

12/16 BUTTON KEYBOARDS

SERIES 84

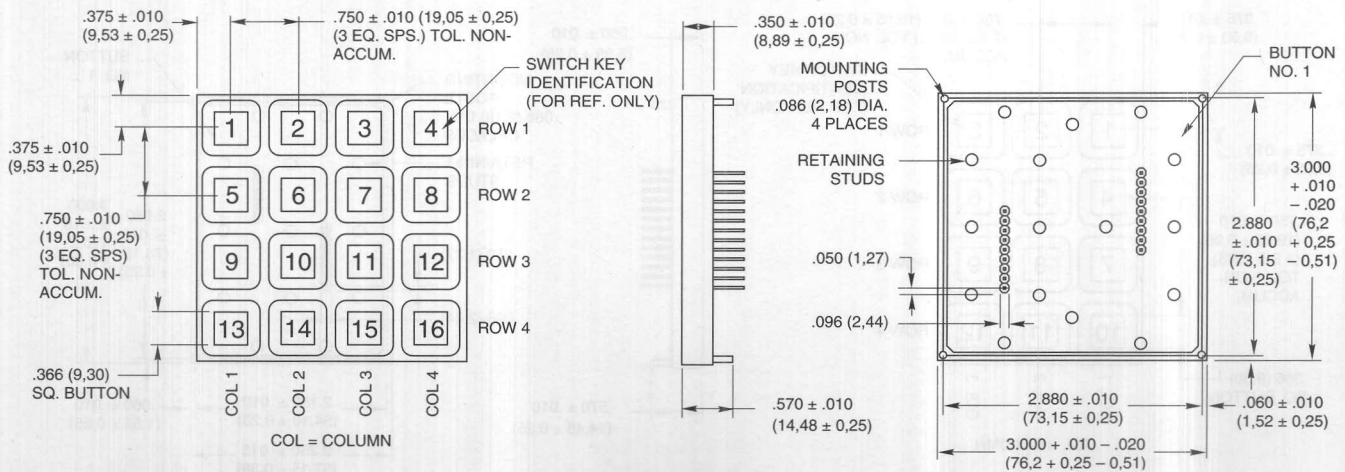
FEATURES

- 3/4" Button Centers
- Post Mounted
- Mounts by Tinnerman Nut or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback



DIMENSIONS In inches (and millimeters)

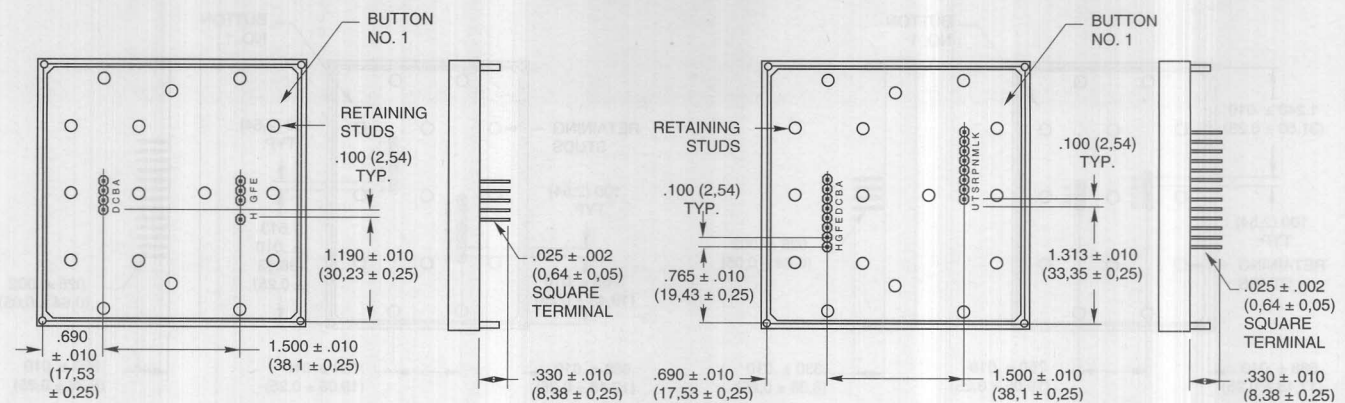
4x4 Keyboard



Termination In inches (and millimeters)

4x4 Matrix Output

Single Pole/Common Bus



CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed.
Terminals are identified on the keyboard.

12 Button Keypads

3x4		CODES																			
		Matrix							Single Pole/Common Bus												
BUTTON LOCATION	1	•			•						•										•
	2		•									•									•
	3			•	•								•								•
	4	•																			•
	5						•						•								•
	6			•																	•
	7	•																			•
	8		•																		•
	9			•																	•
	10	•																			•
	11		•																		•
	12			•																	•
		E	C	D	A	B	F	G	K	J	B	M	L	C	N	E	D	P	G	F	A
		TERMINAL LOCATION																			

16 Button Keypads

4x4		CODES																								
		Matrix								Single Pole/Common Bus																
BUTTON LOCATION	1	●				●					●															●
	2		●									●														●
	3			●			●						●													●
	4				●		●							●												●
	5	●								●																●
	6		●									●														●
	7			●						●																●
	8				●					●																●
	9	●										●														●
	10		●																							●
	11			●						●																●
	12				●					●																●
	13	●										●														●
	14																									●
	15			●																						●
	16				●																					●
		E	F	D	C	A	B	G	H	K	L	A	B	N	M	C	D	P	R	F	E	T	U	H	G	S
		TERMINAL LOCATION																								

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive

Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)

Voltage Breakdown: 250 Vac between mutually insulated parts

Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: Polycarbonate/ABS blend, black; meets UL94V-O

Buttons: ABS plastic, white. Legends are black.

Snap-On-Cap: Clear polycarbonate

Contact Dome: Stainless steel, selectively gold plated

Terminals: Phosphor bronze, solder plated

Operating Features

Button Travel: 0.015" (0,38 mm) nominal total travel

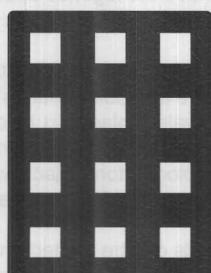
Typical Operating Force: 350 grams

STANDARD LEGENDS

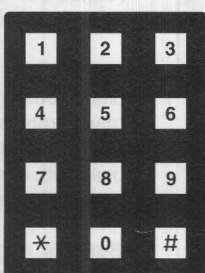
Insertable legend version (legend numbers -101 and -001) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend

insert. This surface can also be ink stamped by GRAYHILL in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0.38 mm) above the surface.

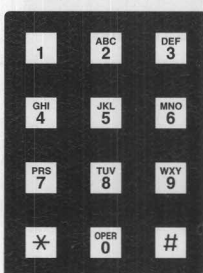
The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends.



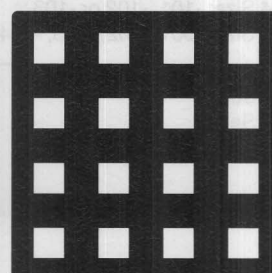
-101 (Insertable)



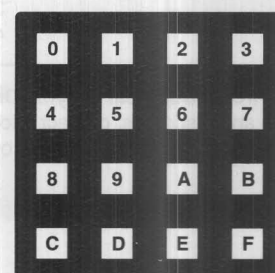
-102 (Molded-in)



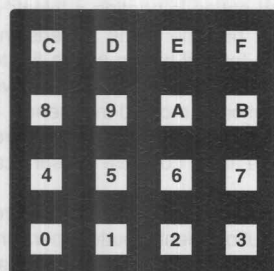
-103 (Molded-in)



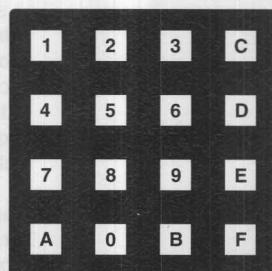
-001 (Insertable)



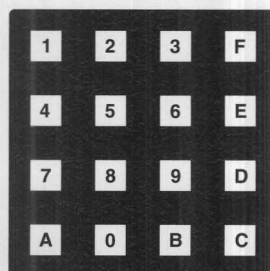
-002 (Molded-in)



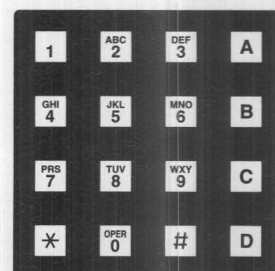
-003 (Molded-in)



-004 (Molded-in)



-005 (Molded-in)



-006 (Molded-in)

12/16 BUTTON KEYBOARDS

INSERTABLE LEGEND SHEETS

For use with -101 or -001 legend option. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	87AC2046
Dry Transfer Lettering, Small	87-DT-2096-088
Dry Transfer Lettering, Medium	87-DT-2096-125
Dry Transfer Lettering, Large	87-DT-2096-187

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

PRINTED LEGENDS For Maximum Versatility

Printing allows you the flexibility to create your own legend using whole words and symbols with various typestyles. Durable epoxy ink printing bonds to the button cap surface. There are two types of button cap printing:

Top Surface Printing—Legend is applied directly to the top of the button. Button is recessed slightly below the keyboard housing.

Sub-Surface Printing—For insertable legend models. Provides maximum wear for printed surfaces. Printed internal button cap is protected by clear snap-on cap.

Printed Typestyles—The typestyle chart illustrates type style, size and approximate character limits for button caps. Grayhill's library of typefaces includes most popular legends.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines END DATA	4 Characters 2 Lines END DATA
1GH125 .138"	ABCDE	3 Characters 1 Line LAD	3 Characters 1 Line LAD
3GH187 .207"	ABCD	2 Characters 1 Line ON	2 Characters 1 Line ON
2GH250 .276"	ABC	N/A N/A	2 Characters 1 Line 15

ORDERING INFORMATION

	Grayhill Series Number
	84 = 3/4" Button centers, post mounting
	Size Option
	A = 3x4
	B = 4x4
	Circuitry Option
	B1 = Matrix code
	C1 = Single pole/common bus
	Standard Legend Choices
	3x4 Size: -101, -102 or -103
	4x4 Size: -001, -002, -003, -004, -005 or -006

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

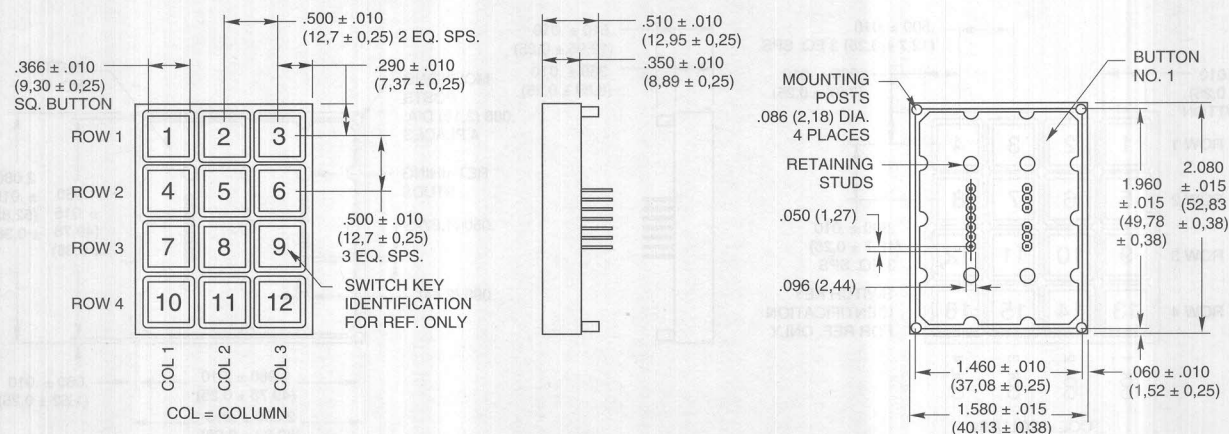
ORDERING INFORMATION— Special Legends

Follow this procedure:

- 1. Basic Keyboard.** Formulate the part number with the exception of the legend suffix.
- 2. Mounting.** Standard mounting is shown in our dimensional drawings. These drawings relate the terminal location to the button legend orientation. It is possible to rotate the button legends by 90°, changing the orientation. When mounting the keypad, it would be rotated 90° to have the legends appear upright. A 3x4 keypad thus becomes a 4x3.
- 3. Color.** Many colors, other than our standard black housing, are available. Buttons can be made from equivalent plastic in black, red, green, blue and yellow. White legends are used with dark color buttons, black with light ones. Other colors available on special order.
- 4. Buttons.** Legends can be printed on button surface and protected by a snap-on cap in a similar fashion to our insertable legend types. A second option is printing a 'blank' button. (One that has the same dimensions as a molded-in legend button with a flat top surface.) Disadvantage is legend wear over time. A third option is molded-in legends, usually requiring tooling. Molded buttons are available with a flat or concave top surface.
- 5. Legends.** Specify the legend requirements for each button. Identify buttons per our dimensional drawings. Caution if keypad has been rotated.

DIMENSIONS In inches (and millimeters)

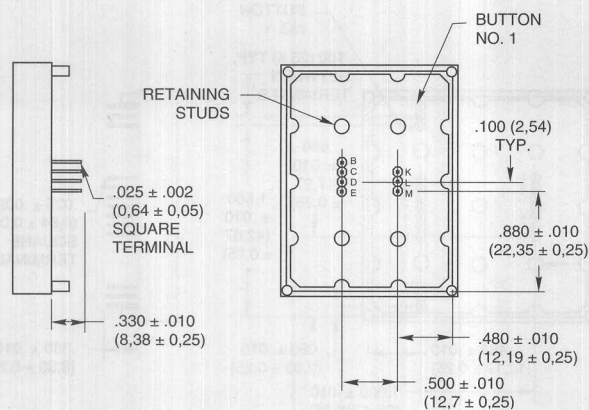
3x4 Keyboard



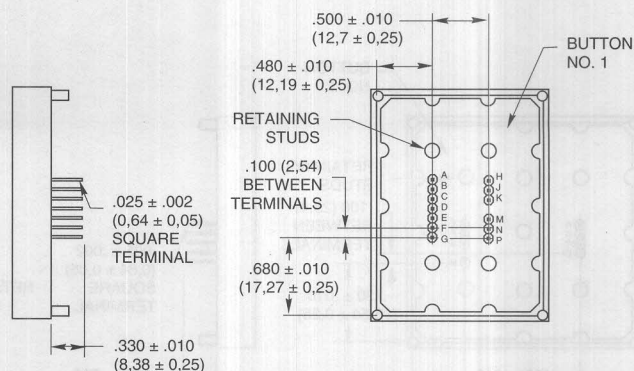
Termination In inches (and millimeters)

3x4

Matrix Output



Single Pole/Common Bus



See pages C-22 and C-23 for code and truth tables, specifications, legends and ordering information.

12/16 BUTTON KEYBOARDS

SERIES 83

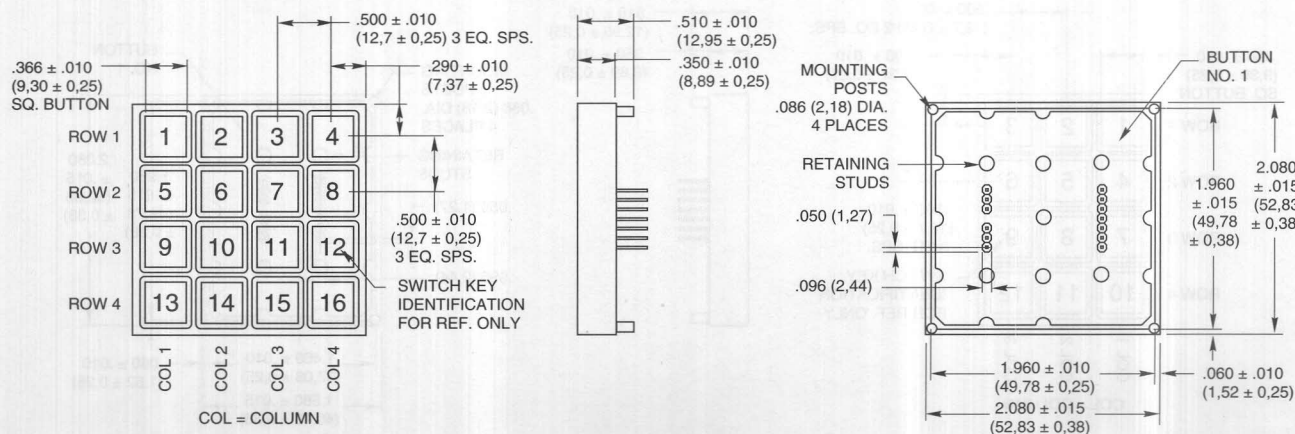
FEATURES

- 1/2" Button Centers
- Post Mounted
- Mount by Tinnerman Nut or Heat Upset Post
- Snap-Dome Contact Provides Positive Feedback



DIMENSIONS In inches (and millimeters)

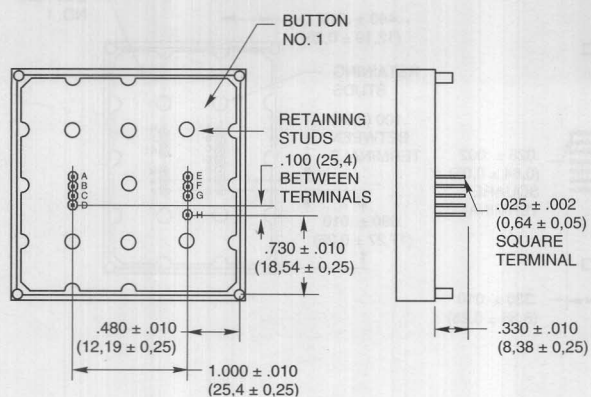
4x4 Keyboard



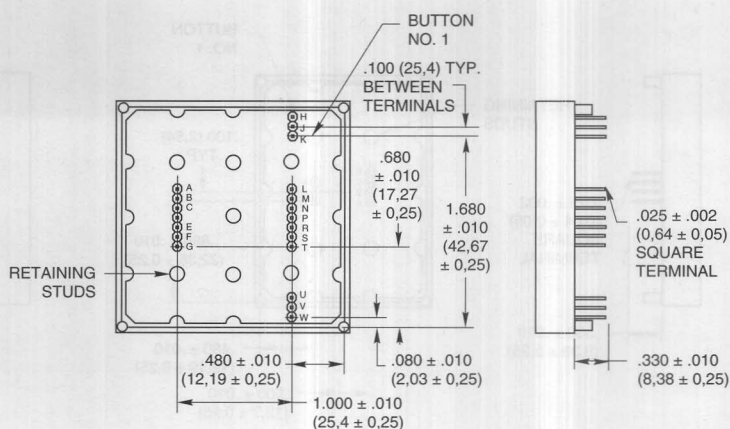
Termination In inches (and millimeters)

4x4

Matrix Output



Single Pole/Common Bus



CODE AND TRUTH TABLES

Dots in the chart indicate connected terminals when switch is closed.
Terminals are identified on the keyboard.

12 Button Keypads

3x4		CODES																					
		Matrix						Single Pole/Common Bus															
BUTTON LOCATION	1	•			•												•						
	2		•			•											•						
	3			•		•											•						
	4	•															•						
	5		•														•						
	6			•			•										•						
	7	•															•						
	8		•														•						
	9			•													•						
	10	•															•						
	11		•														•						
	12			•													•						
		K	D	E	B	C	L	M	K	H	A	J	C	B	N	E	F	M	P	G	D		
		TERMINAL LOCATION																					

16 Button Keypads

4x4		CODES															
		Matrix								Single Pole/Common Bus							
BUTTON LOCATION	1	•								•							•
	2		•														•
	3			•													•
	4				•												•
	5	•				•											•
	6		•														•
	7			•													•
	8				•												•
	9	•															•
	10		•														•
	11			•													•
	12				•												•
	13	•															•
	14		•														•
	15			•													•
	16				•												•
		E F D C A B G H								H J K A L M C B T S E F W V U G P							
		TERMINAL LOCATION															

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive

Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)

Voltage Breakdown: 250 Vac between mutually insulated parts

Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: ABS polycarbonate, black

Buttons: ABS plastic, white. Legends are black.

Snap-On-Cap: Clear polycarbonate

Contact Dome: Stainless steel, selectively gold plated

Terminals: Phosphor bronze, solder plated

Operating Features

Button Travel: 0.015" (0,38 mm) nominal total travel

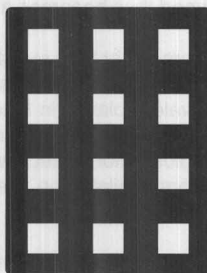
Typical Operating Force: 350 grams

STANDARD LEGENDS

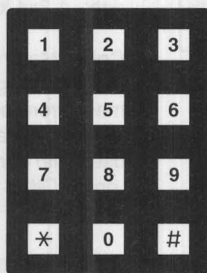
Insertable legend version (legend numbers -101 and -001) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend

insert. This surface can also be ink stamped by GRAYHILL in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface.

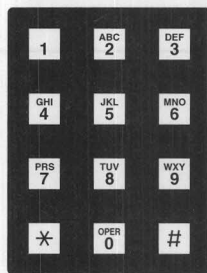
The legend sheet information follows the legend presentation. All other legends incorporate molded-in (two shot) legends.



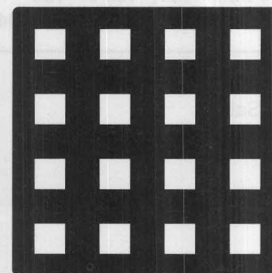
-101 (Insertable)



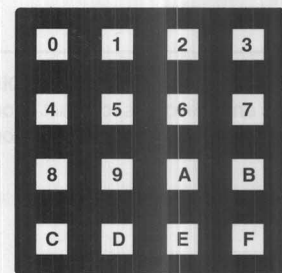
-102 (Molded-in)



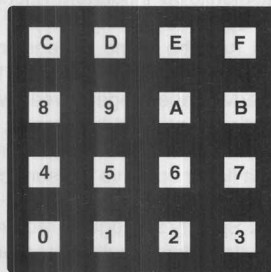
-103 (Molded-in)



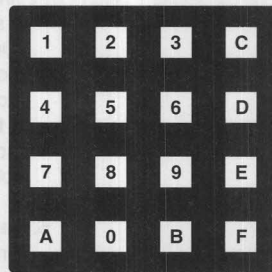
-001 (Insertable)



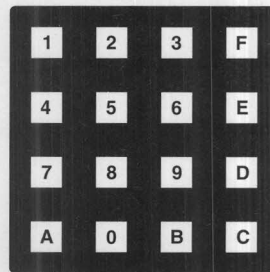
-002 (Molded-in)



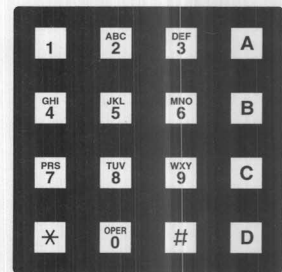
-003 (Molded-in)



-004 (Molded-in)



-005 (Molded-in)



-006 (Molded-in)

12/16 BUTTON KEYBOARDS

INSERTABLE LEGEND SHEETS

For use with -101 or -001 legend option. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided or on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	87AC2046
Dry Transfer Lettering, Small	87-DT-2096-088
Dry Transfer Lettering, Medium	87-DT-2096-125
Dry Transfer Lettering, Large	87-DT-2096-187

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

PRINTED LEGENDS





For Maximum Versatility

Printing allows you the flexibility to create your own legend using whole words and symbols with various typestyles. Durable epoxy ink printing bonds to the button cap surface. There are two types of button cap printing:

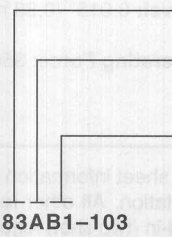
Top Surface Printing—Legend is applied directly to the top of the button. Button is recessed slightly below the keyboard housing.

Sub-Surface Printing—For insertable legend models. Provides maximum wear for printed surfaces. Printed internal button cap is protected by clear snap-on cap.

Printed Typestyles—The typestyle chart illustrates type style, size and approximate character limits for button caps. Grayhill's library of typefaces includes most popular legends.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines 	4 Characters 2 Lines 
1GH125 .138"	ABCDE	3 Characters 1 Line 	3 Characters 1 Line 
3GH187 .207"	ABCD	2 Characters 1 Line 	2 Characters 1 Line 
2GH250 .276"	ABC	N/A N/A	2 Characters 1 Line 

ORDERING INFORMATION



Grayhill Series Number
83 = 3/4" Button centers, post mounting

Size Option
A = 3x4
B = 4x4

Circuitry Option
B1 = Matrix code
C1 = Single pole/common bus

Standard Legend Choices
3x4 Size: -101, -102 or -103
4x4 Size: -001, -002, -003, -004, -005 or -006

83AB1-103

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ORDERING INFORMATION—

Special Legends

Follow this procedure:

- Basic Keyboard.** Formulate the part number with the exception of the legend suffix.
- Mounting.** Standard mounting is shown in our dimensional drawings. These drawings relate the terminal location to the button legend orientation. It is possible to rotate the button legends by 90°, changing the orientation. When mounting the keypad, it would be rotated 90° to have the legends appear upright. A 3x4 keypad thus becomes a 4x3.
- Color.** Many colors, other than our standard black housing, are available. Buttons can be made from equivalent plastic in black, red, green, blue and yellow. White legends are used with dark color buttons, black with light ones. Other colors available on special order.
- Buttons.** Legends can be printed on button surface and protected by a snap-on cap in a similar fashion to our insertable legend types. A second option is printing a 'blank' button. (One that has the same dimensions as a molded-in legend button with a flat top surface.) Disadvantage is legend wear overtime. A third option is molded-in legends, usually requiring tooling. Molded buttons are available with a flat or concave top surface.
- Legends.** Specify the legend requirements for each button. Identify buttons per our dimensional drawings. Caution if keypad has been

SERIES 86

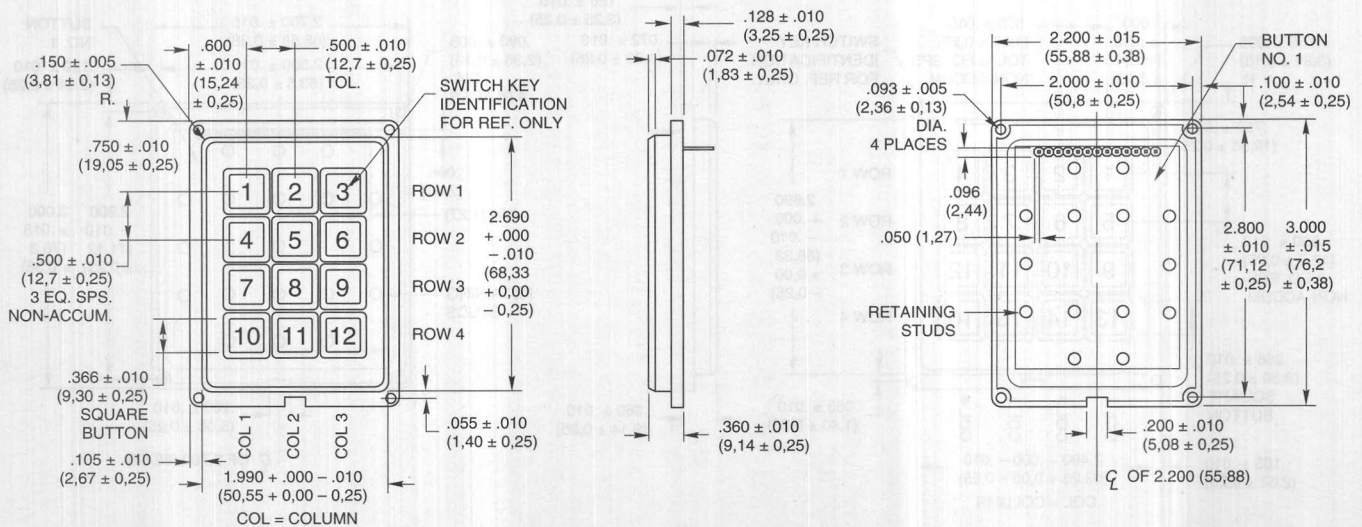
FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback

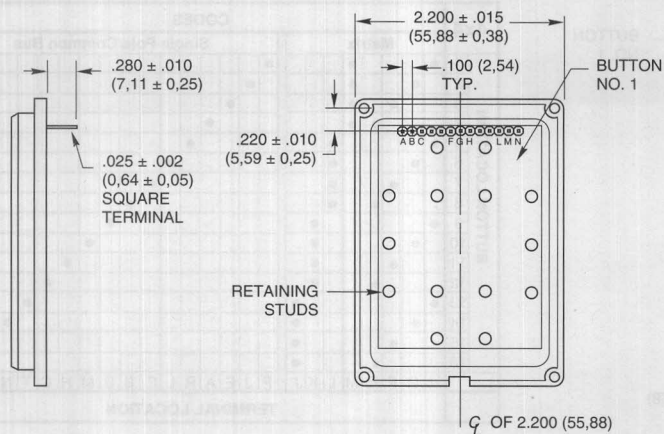


DIMENSIONS In inches (and millimeters)

3x4 Keyboard

**Termination** In inches (and millimeters)

3x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4		CODES																				
		Matrix								Single Pole/Common Bus												
BUTTON LOCATION	1	●				●															●	
	2		●																		●	
	3			●		●															●	
	4	●					●														●	
	5		●					●													●	
	6			●			●														●	
	7	●								●											●	
	8																				●	
	9			●						●												●
	10	●																			●	
	11		●																		●	
	12			●																	●	
		F	E	D	K	J	H	G	J	E	A	K	F	B	L	G	C	M	H	D	N	
TERMINAL LOCATION																						

See page C-27 for specifications, legends and ordering information.

12/16/20 BUTTON KEYBOARDS

SERIES 86

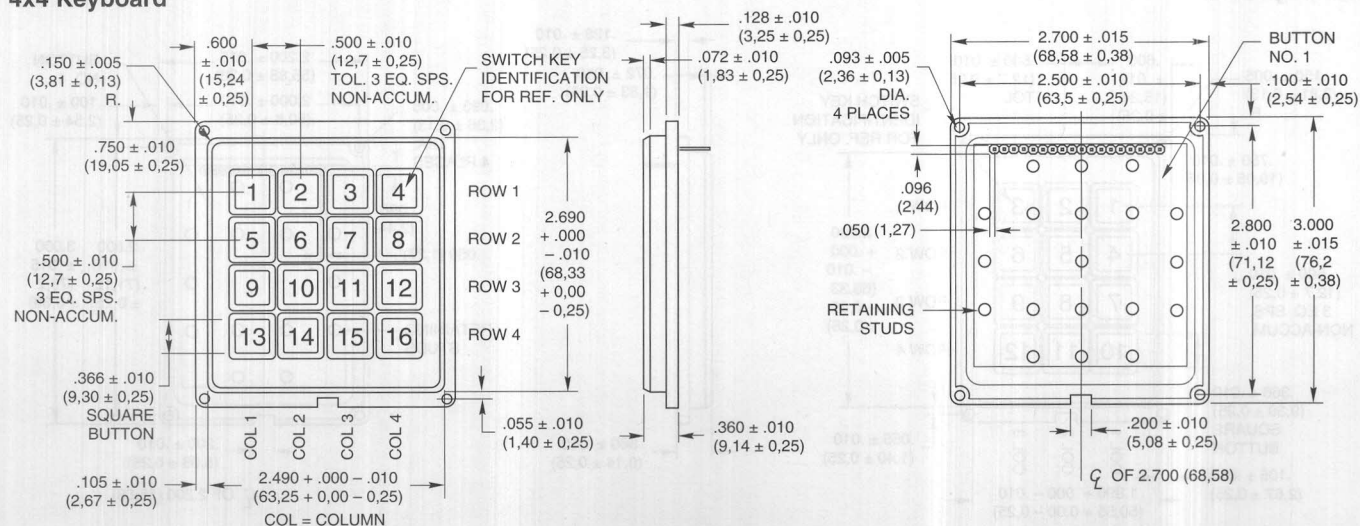
FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback



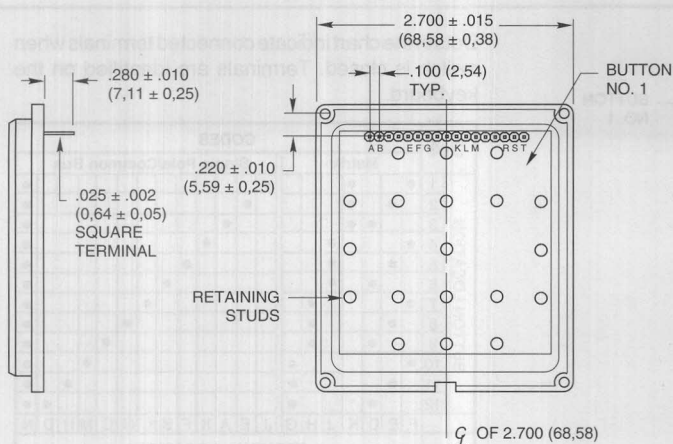
DIMENSIONS In inches (and millimeters)

4x4 Keyboard

**Termination** In inches (and millimeters)

Code and Truth Table

4x4



Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

[illegible]

See page C-27 for specifications, legends and ordering information.

SERIES 86

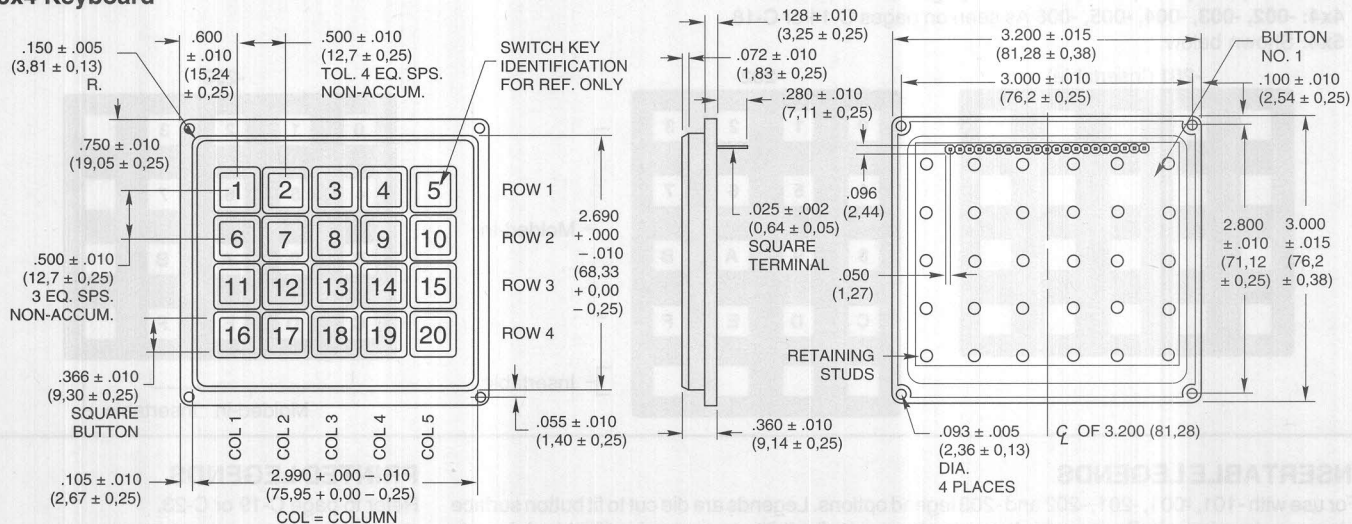
FEATURES

- 1/2" Button Centers
- Flange Mounted
- Top Surface or Sub Surface Mounting
- Snap-Dome Contact Provides Positive Feedback



DIMENSIONS In inches (and millimeters)

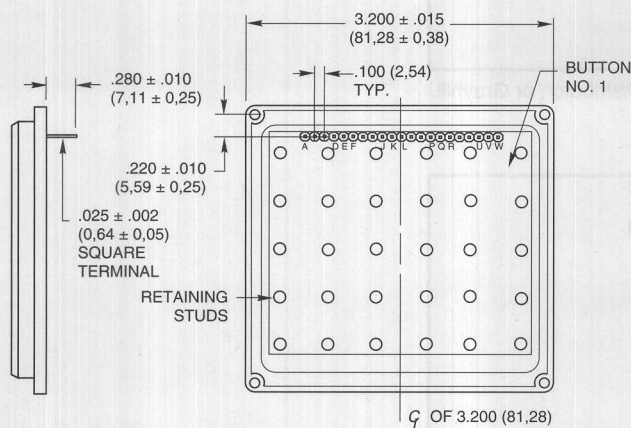
5x4 Keyboard

**Termination** In inches (and millimeters)

Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

5x4



5x4		CODES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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BUTTON LOCATION	1	•																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		

See page C-27 for specifications, legends and ordering information.

12/16/20 BUTTON KEYBOARDS

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive

Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)

Voltage Breakdown: 250 Vac between mutually insulated parts

Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Operating Temperature: -40°C to +80°C

Materials and Finishes

Housing: ABS polycarbonate, black

Buttons: ABS plastic, white. Legends are black.

Snap-On-Cap: Clear polycarbonate

Contact Dome: Stainless steel, selectively gold plated

Terminals: Phosphor bronze, solder plated

Operating Features

Button Travel: 0.015" nominal total travel

Typical Operating Force: 350 grams

STANDARD LEGENDS

Insertable legend version (legend numbers -101, -001, -201 and row or column indicated in -202 and -203) has a removable cap. The revealed button surface can be legended by an insert or a dry transfer of a blank legend

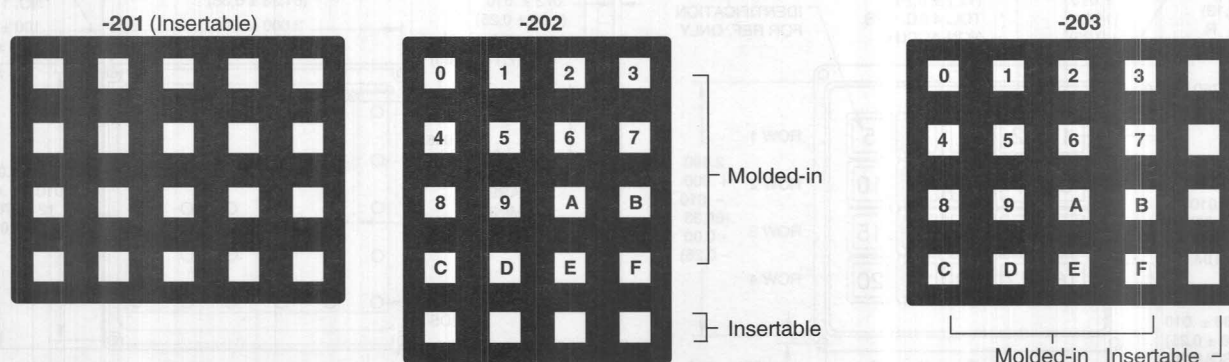
insert. This surface can also be ink stamped by GRAYHILL in higher volume quantities. When the cap is replaced, the assembly extends approximately .015" (0,38 mm) above the surface. The legend sheet information follows the leg-

end presentation. All other legends incorporate molded-in (two shot) legends with the exception of legend numbers -202 and -203. The blank legends or spaces in legends -202 and -203 are insertable legends, others are molded-in.

3x4 : -101, -102, -103, -001 As seen on pages C-14 or C-18

4x4 : -002, -003, -004, -005, -006 As seen on pages C-14 or C-18

5x4: Shown below



INSERTABLE LEGENDS

For use with -101, -001, -201, -202 and -203 legend options. Legends are die cut to fit button surface when cap is removed. Dry transfer legends offer some flexibility to customize the blank inserts included on the sheet of popular legend letters, words and symbols provided on the insertable legends sheet.

Description	Part No.
Sheet of Legend Inserts	87AC2046
Dry Transfer Lettering, Small	87-DT-2096-088
Dry Transfer Lettering, Medium	87-DT-2096-125
Dry Transfer Lettering, Large	87-DT-2096-187

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

PRINTED LEGENDS

Refer to page C-19 or C-23.

Ordering Information—Special Legends

ORDERING INFORMATION

	Grayhill Series Number
	86 = 1/2" Button centers, post mounting
	Size Option
	A = 3x4 B = 4x4 J = 5x4
	Circuitry Option
	B2 = Matrix code C2 = Single pole/common bus
	Standard Legend Choices
	3x4 Size: -101, -102 or -103
	4x4 Size: -001, -002, -003, -004, -005 or -006
	5x4 Size: -201, -202, or -203

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 88

Versatile Keyboards That Work Indoors Or Outdoors

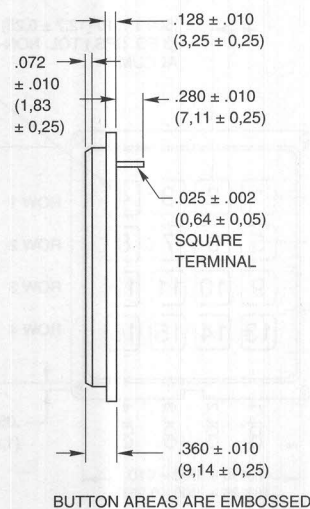
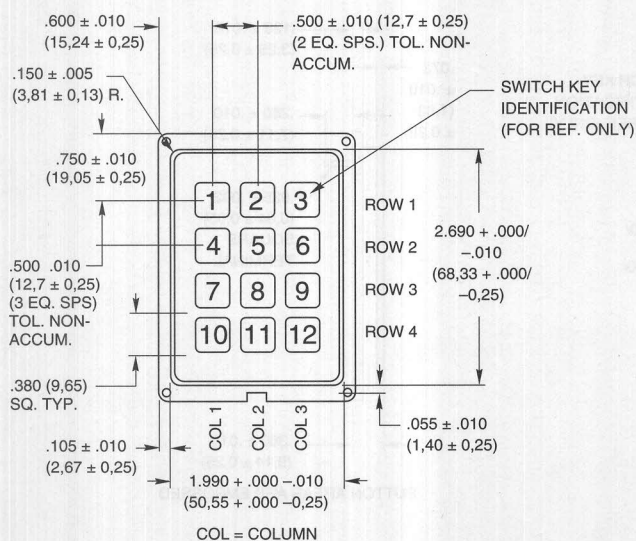
FEATURES

- Sealed Keyboard
- Colorful Graphic Overlay
- Audible, Snap-Dome Contact
- User Legendable Styles
- 3,000,000 Operations Per Button
- Optional Panel Seal Gasket to Protect Your Equipment

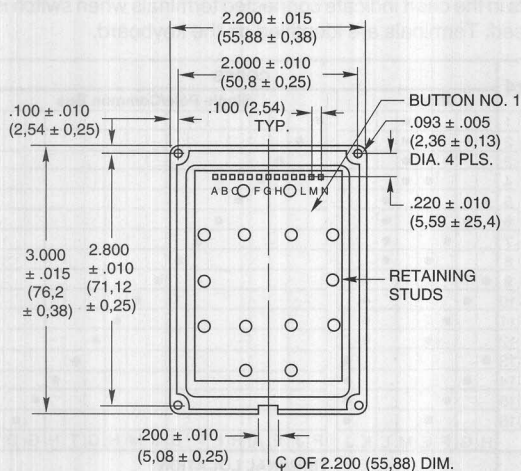


DIMENSIONS In inches (and millimeters)

3x4 Keyboard

**Termination** In inches (and millimeters)

3x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4		CODES																
		Matrix								Single Pole/Common Bus								
BUTTON LOCATION	1	•				•				•							•	
	2		•								•						•	
	3			•								•					•	
	4	•							•				•				•	
	5		•							•				•			•	
	6			•											•		•	
	7	•							•							•	•	
	8		•														•	
	9			•														•
	10				•					•								•
	11	•																•
	12		•							•								•
		F	E	D	K	J	H	G	J	G	I	E	A	K	F	B	L	G
		TERMINAL LOCATION																

See pages C-31 through C-33 for specifications, legends, sealing of keyboards and ordering information.

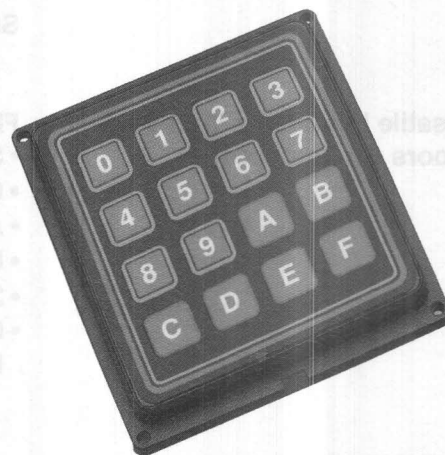
SEALED KEYBOARDS

SERIES 88

Versatile Keyboards that Work Indoors or Outdoors

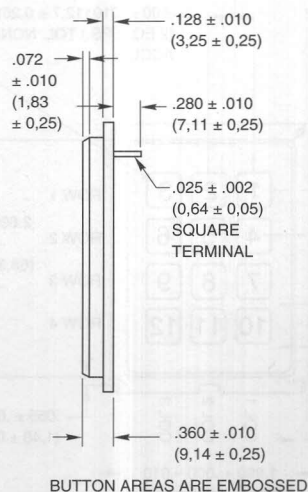
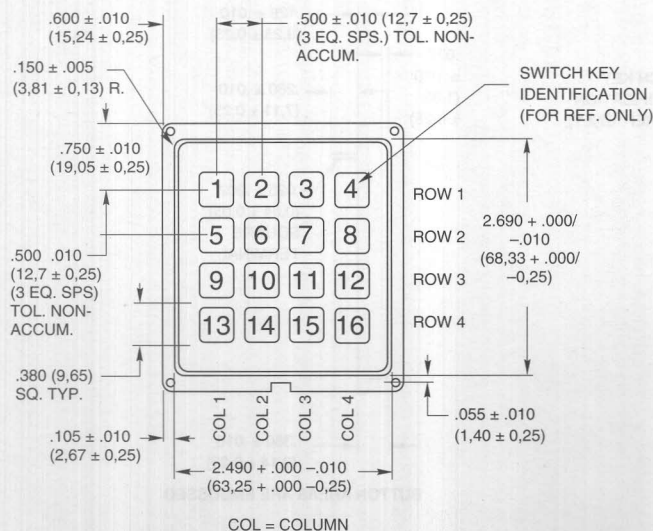
FEATURES

- Sealed Keyboard
- Colorful Graphic Overlay
- Audible, Snap-Dome Contact
- User Legendable Styles
- 3,000,000 Operations Per Button
- Optional Panel Seal Gasket to Protect Your Equipment

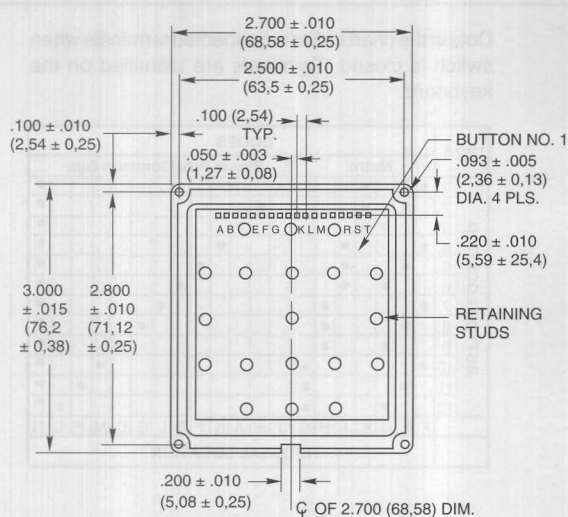


DIMENSIONS In inches (and millimeters)

4x4 Keyboard

**Termination** In inches (and millimeters)

4x4



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

4x4		CODES																									
		Matrix								Single Pole/Common Bus																	
BUTTON LOCATION	1	•				•						•															•
	2		•				•						•														•
	3			•				•						•													•
	4				•		•								•												•
	5	•									•																•
	6		•									•															•
	7			•									•														•
	8				•			•																			•
	9	•													•												•
	10		•													•											•
	11			•													•										•
	12				•													•									•
	13	•																							•		•
	14		•																							•	•
	15			•																							•
	16				•																						•
		H	G	F	E	M	L	K	J	P	J	E	A	R	L	F	B	S	M	H	C	T	N	G	D	I	
		TERMINAL LOCATION																									

See pages C-31 through C-33 for specifications, legends, sealing of keyboards and ordering information.

SEALED KEYBOARDS

SPECIFICATIONS

Rating Criteria

Rating at 24 Vdc: 10 milliamps, resistive

Contact Resistance: Compatible with MOS, TTL and DTL (10 ohms maximum)

Voltage Breakdown: 250 Vac between mutually insulated parts

Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Temperature: -40°C to +80°C

Operating Features

Button Travel: 0.015"(0,38 mm) nominal total travel

Typical Operating Force: 350 grams

Materials and Finishes

Housing: ABS polycarbonate, black

Graphic Overlay: Polyester

Contact Dome: Stainless steel, selectively gold plated

Terminals: Copper alloy, CDA No. 725. Tin-lead plated

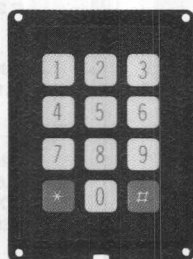
STANDARD LEGENDS

Colorful graphic overlays are polyester with a tough acrylic bond to provide maximum protection against dirt and moisture. Second surface printed, the overlay wipes clean and continues to look bright and bold throughout the keyboard life. Available through distributors.

For instant custom legends, order separate blank keyboards as indicated in the Ordering Information section and choose one of the clear window overlays below; then order a sheet of legend inserts. Or, if you prefer, order the keyboard custom printed by Grayhill; see Ordering Information.



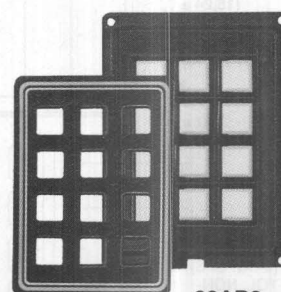
-143



-152



-172

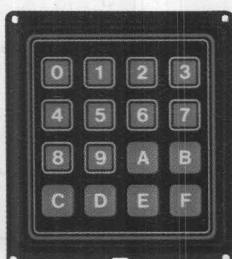


88-101

88AB2,
88AC2



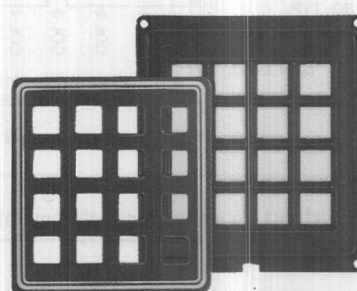
-052



-072

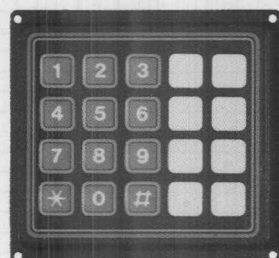


-082



88-001

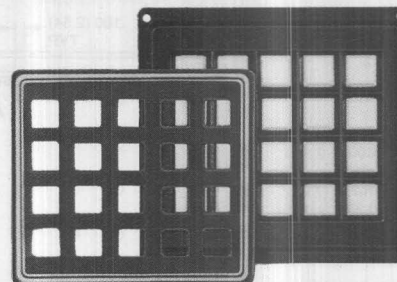
88BB2,
88BC2



-252



-262



88-201

88JB2, 88JC2

SEALING OF KEYBOARDS

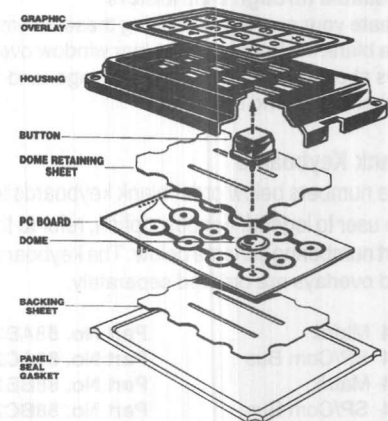
The graphic legend is silk-screen printed on the second surface of a clear polyester film, providing maximum legend protection. It withstands high humidity, and it is resistant to scratching, marring, and dulling of the surface caused by fingernails, wiping cloths, and cleaning materials. It has excellent solvent resistance to water, petroleum oil, alcohols and aliphatic hydrocarbons.

These common liquids do not attack the overlay: 5% acetic acid, 5% citric acid, 2% detergent solution, soapy water, 30% hydrogen peroxide, wine, beer, whiskey, coffee, cocoa, milk, tomato juice, lemon juice, etc. Hydrocarbons, ketones and freon do not affect the overlay. But, we recommend that you do not subject the

keyboard to these chemicals, since they may affect the switch housing, which is ABS plastic. To discuss a particular solvent, contact GRAYHILL.

Protect your equipment in outdoor or harsh environmental conditions by sealing the keyboard to the equipment panel. Use an optional gasket with the keyboard. There are two types of gaskets: one for mounting the keyboard beneath the panel, and one for mounting it above the equipment panel. See Panel Seal Gaskets below.

The contact system is internally sealed by a special adhesive backed sheet that holds the domes in position on the PC board.



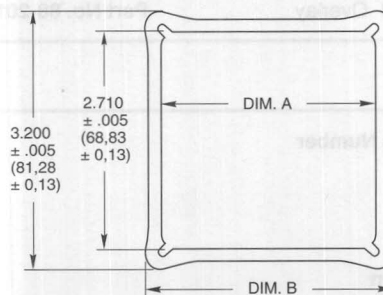
PANEL SEAL GASKETS

Weatherproof and waterproof your subpanel and topside mounted keyboards with optional panel seal gaskets.

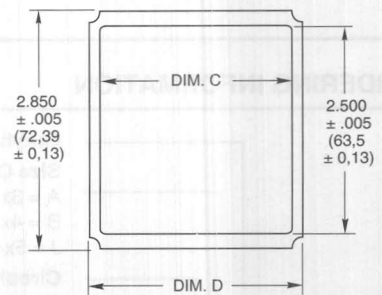
Subpanel keyboard gasket is .062" (1,57 mm) thick; topside keyboard gasket is .094" (2,39 mm).

Material is cellulose fiber, foam, nitrile rubber. Order gaskets separately from keyboard.

Subpanel Mounting



Topside Mounting



Subpanel 3x4 **Part No. 88M2001-2**
Subpanel 4x4 **Part No. 88M2009-2**
Subpanel 5x4 **Part No. 88M2019-1**

Topside 3x4 **Part No. 88M2012-1**
Topside 4x4 **Part No. 88M2015-1**
Topside 5x4 **Part No. 88M2018-1**

Size of Keyboard	Subpanel Mount		Topside Mount	
	Dim. A	Dim. B	Dim. C	Dim. D
3x4	2.010 ± .005 (51,05 ± 0,13)	2.400 ± .005 (60,96 ± 0,13)	1.800 ± .005 (45,72 ± 0,13)	2.040 ± .005 (51,82 ± 0,13)
4x4	2.510 ± .005 (63,75 ± 0,13)	2.900 ± .005 (73,66 ± 0,13)	2.300 ± .005 (58,42 ± 0,13)	2.540 ± .005 (64,52 ± 0,13)
5x4	3.010 ± .005 (76,45 ± 0,13)	3.400 ± .005 (86,36 ± 0,13)	2.800 ± .005 (71,12 ± 0,13)	3.040 ± .005 (77,22 ± 0,13)

SEALED KEYBOARDS

INSTANT CUSTOM LEGENDS

Available through Distributors

Create your own legends using these 3 items: 1) a blank keyboard, 2) the clear window overlays shown on Standard Legend page, and 3) a sheet of legend inserts.

Blank Keyboards

The numbers below order blank keyboards for the user to legend. For description, refer to the part numbering scheme below. The keyboards and overlays are ordered separately.

3x4 Matrix	Part No. 88AB2
3x4 SP/Com Bus	Part No. 88AC2
4x4 Matrix	Part No. 88BB2
4x4 SP/Com Bus	Part No. 88BC2
5x4 Matrix	Part No. 88JB2
5x4 SP/Com Bus	Part No. 88JC2

Legend Insert Sheet and Dry Transfers

Self-adhesive inserts are die-cut to fit the button. Legends are printed in black on clear film in News Gothic Condensed type style. They include letters A through Z, numbers 0-9, telephone legends, commonly used words and symbols, and blanks.

Part No. 87AC2046

Use matching dry transfer lettering on blank inserts of legend sheet: upper and lower case letters, 0-9, and common symbols.

Small Print	Part No. 87-DT-2096-088
Medium Print	Part No. 87-DT-2096-125
Large Print	Part No. 87-DT-2096-187

Clear Window Overlays

Order separately from keyboards. See also ordering information.

3x4 Overlay	Part No. 88-101
4x4 Overlay	Part No. 88-001
5x4 Overlay	Part No. 88-201

PRINTED LEGENDS

Not available through Distributors

For medium volume applications, or where legends cannot be produced by the self legend method, you can order epoxy ink printed legends. Virtually anything which can be photographed can be printed. Grayhill will print your legend and then add the clear window overlay.

Type I.D. No.	Simulated Style & Size	Character & Line Limitations *
4GH088	ABCDEFGH	END DATA
1GH125	ABCDE	LAD
3GH187	ABCD	ON
2GH250	ABC	15

ORDERING INFORMATION

	Grayhill Series Number
	Size Option
	A = 3x4 B = 4x4 J = 5x4
	Circuitry Option
	B2 = Matrix code C2 = Single pole/common bus
	Standard Legend Choices
	3x4 Size: -143, -152, -172 or -182
	4x4 Size: -052, -072 or -082
	5x4 Size: -252 or -262

Available from your local Grayhill Distributor

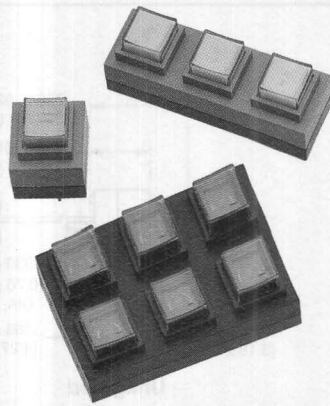
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 82

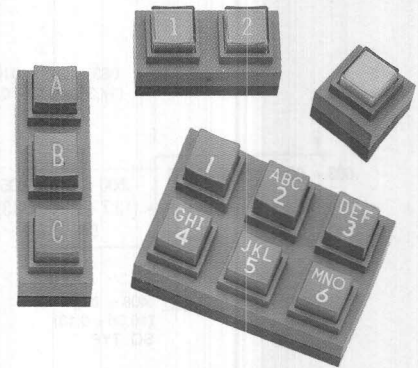
**Build A Custom Keyboard
With Identical Button Distances
No Matter How You Stack Them.**

FEATURES

- $\frac{11}{16}$ " Between Button Centers
- Long, Stroke, Wiping Contact
- Lightable Modules
- Choice of 5 Circuitries with Unlighted Modules
- User Legendable



Lightable Modules



Unlighted Modules

MOUNTING

Designed to plug into any printed circuit board from $\frac{1}{16}$ " to $\frac{1}{8}$ " thick, modules stack in any configuration, maintaining $\frac{11}{16}$ " button centers.

For Lightable Modules which will be continuously lit, mixing vertically mounted modules with horizontally mounted modules is not recom-

mended; the orientation of the rectangular, lighted area will differ. See drawings.

See Figure 1 Panel Cutout diagram for 6 button module mounting dimensions. Refer to drawings for other module dimensions.

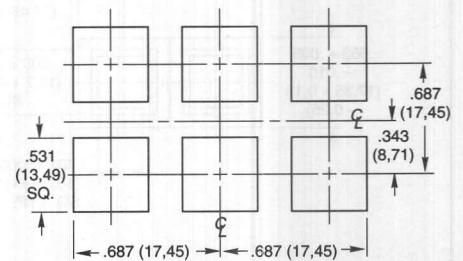


Figure 1 Panel Mount Cutout Diagram

LIGHTABLE MODULES

Light Source and Lamp Mounting

Each lightable button fits over a T-1 size LED or incandescent lamp mounted to PC board (see Figure 2-2a). The height of the lamp should not exceed .250" (6.35 mm) from the surface of the board. (Note: Grayhill does not manufacture or sell LED's or incandescent lamps).

For easy light replacement, mount the lamp or LED through the back or solder side of the board (see Figure 2). This method of mounting allows you to replace light source without removing the keyboard module. The other method of light mounting (Figure 2a) requires desoldering the keyboard module then

desoldering the lamp when it's necessary to replace the light source.

The chart below lists ratings for a size T-1 incandescent lamp. To extend the life of the lamp, use an alternating current and reduced voltage. The chart also lists maximum temperatures the module can withstand. For higher temperatures, Grayhill offers modules made of special plastics, polyester switch housing and polycarbonate internal button. All measurements were determined under laboratory conditions. (Mounted model continuously lit in temperature controlled oven with continuously circulating air for 24 hours.)

Incandescent Lamp—Size T-1

Lamp Number*	Intensity and Mean Spherical Candle Power	Volts	Service Life in Hours	Current Per Lamp	Maximum Allowable Ambient Temperature	Max. Temp. for Modules With Special Plastics
715	Bright .15 MSCP	5 V	40,000	115 mA	130°F	200°F
680	Moderate .03 MSCP	5 V	100,000	60 mA	150°F	220°F

*Lamps not available from Grayhill.

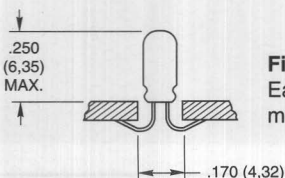


Figure 2
Easy replacement
mounting

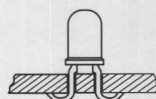
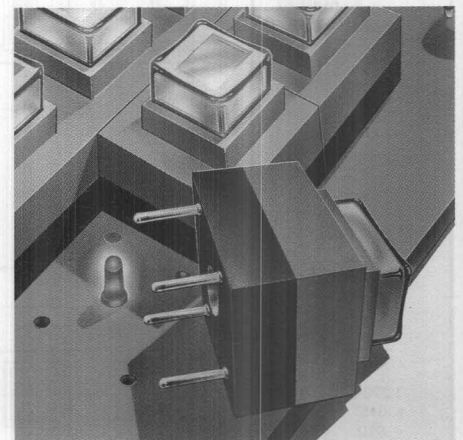
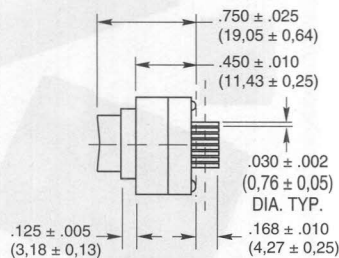
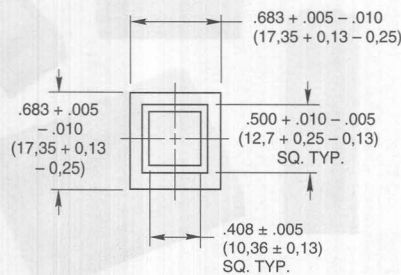


Figure 2a
Mounted from
component side

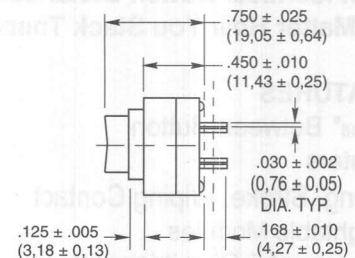


KEYBOARD MODULES

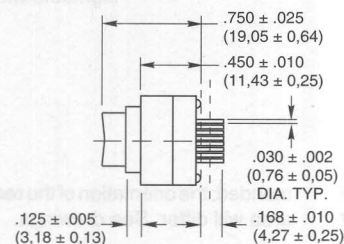
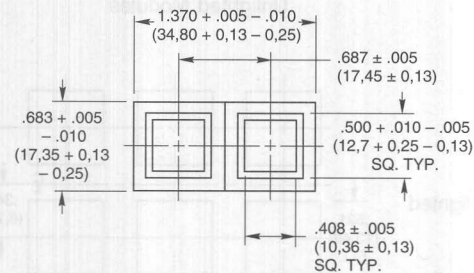
DIMENSIONS In inches (and millimeters)



Unlighted



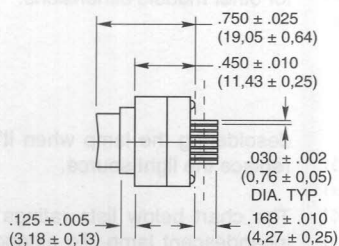
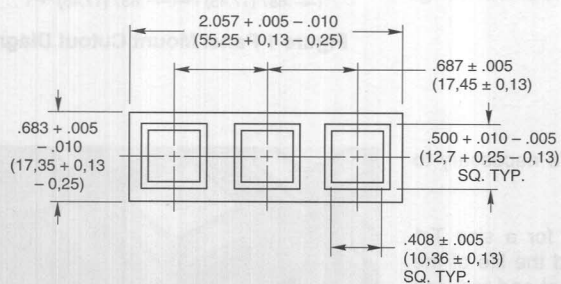
Lightable



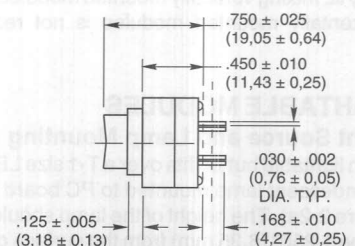
Unlighted (only)



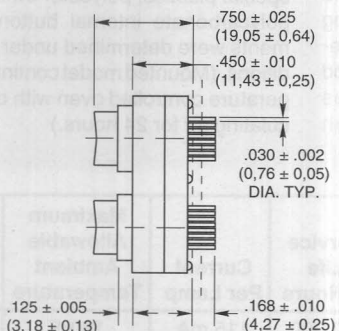
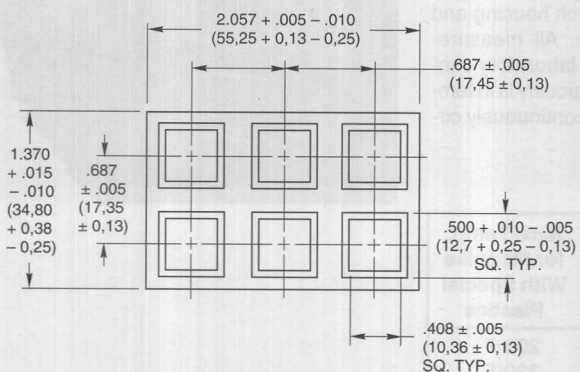
Lightable



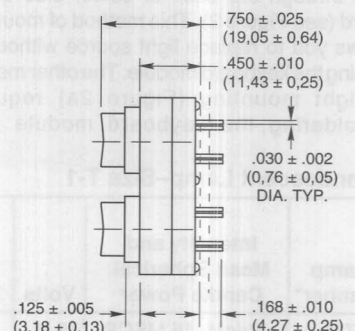
Unlighted



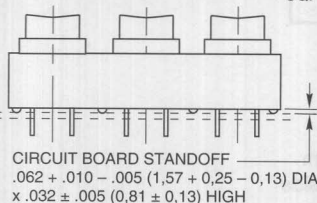
Lightable



Unlighted



Lightable



See page C-37 to C-39 for circuitry, specifications, legends and ordering information.

TERMINAL ARRANGEMENTS

For continuously lit keyboards, mixing horizontally and vertically mounted modules is not recommended. See lamp mounting on page C-34.

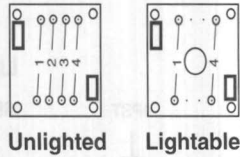
Letters shown in front views are for identification only; product is marked on back as shown. Pin locations correspond to circuit diagrams.

Vertical Mount

Button Identification



Rear Views and Pin Locations



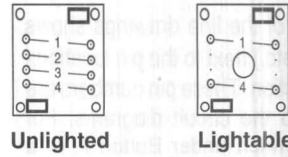
Unlighted Lightable

Button Identification

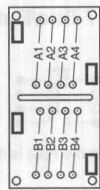
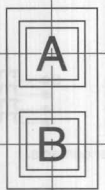


Horizontal Mount

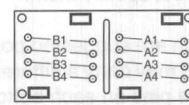
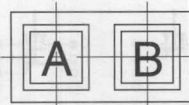
Rear Views and Pin Locations



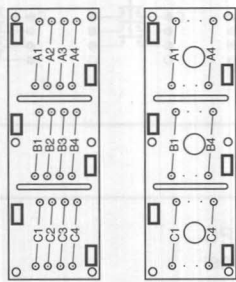
Unlighted Lightable



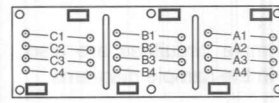
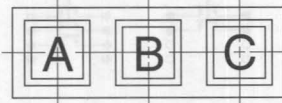
Unlighted (only)



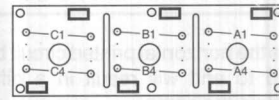
Unlighted (only)



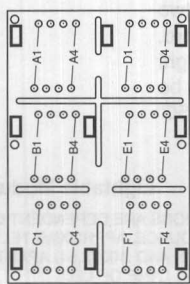
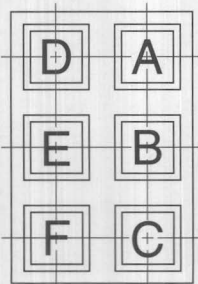
Unlighted Lightable



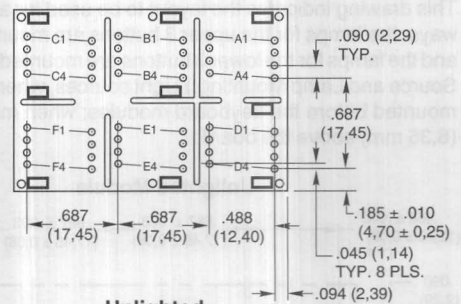
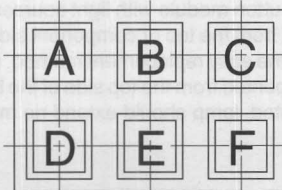
Unlighted



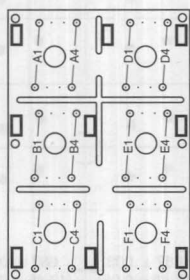
Lightable



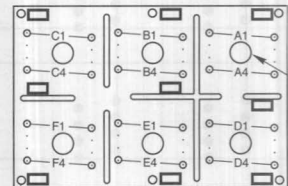
Unlighted



Unlighted



Lightable



CIRCUIT BOARD STANDOFFS
 $.066 \pm .006 (1,68 \pm 0,15)$ DIA. X
 $.032 \pm .005 (0,81 \pm 0,13)$ HIGH

Lightable

See page C-37 to C-39 for circuitry, specifications, legends and ordering information.

561 Hillgrove Avenue • LaGrange, Illinois 60525 • USA • Phone: (708) 354-1040 • Fax: (708) 354-2820 • <http://www.grayhill.com>

SPECIFICATIONS

Rating

Rating at 5 Vdc: 100 milliamps

Contact Resistance: 25 milliohms or less on a new switch

Voltage Breakdown: 250 Vac between mutually insulated parts

Insulation Resistance: 1,000 megaohms minimum

Life Expectancy: 1,000,000 operations

Contact Bounce: 10 milliseconds or less for the life of the switch

Materials and Finishes

Pin Contact: Brass, gold plate over nickel plate

Spring Contact: Copper alloy, gold plate over nickel plate

STANDARD LEGENDS

Telephone Keypad



Two 6-button modules form the keypad. White telephone legend is molded into a gray button. SPST, 2PST, 3PST, and 4PST circuitry available from distributors, see

ordering information; order special circuitry from Grayhill.

Non-Legend, Lighted Modules

Standard lightable module configurations without cap slot for insertable legend.

Housing: ABS plastic (gray)

Base: PPS plastic (black)

Return Spring: Tinned music wire

Other Parts: (By Module and Legend Style): For unlighted module with molded legends or top surface printed legends. Internal Button is acetal and the Button is ABS plastic (gray).

For unlighted module with sub-surface printed legends or insertable legends, Internal Button is acetal; Internal Cap is ABS plastic (gray); and Clear Cap is polycarbonate plastic. For lightable modules, the Internal Button and the Clear Cap are polycarbonate. The Internal Cap for gray modules is acrylic; for the black modules, the Internal Cap with window is polycarbonate.

For special lightable modules for higher temperatures, internal button cap is polycarbonate and housing is polyester.

Operating Features

Action: Momentary, wiping contact

Button Travel: 0.130" (3.30 mm) total travel

Overtravel: 0.080" nominal

Operating Force: 8 ± 3 ounces (depends on number of poles.)

Soldering Instructions

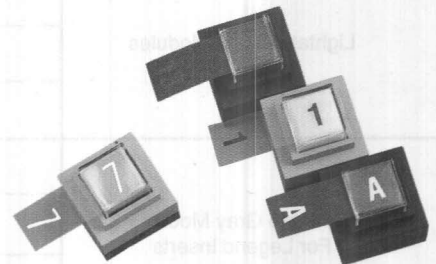
Series 82 Keyboard Modules have been successfully tested for heat resistance to soldering up to 260°C (500°F) for a maximum of 5 seconds. Careful flux cleaning is required since the switch is not sealed. For applications in excess of these limits or that require vapor spray or immersion cleaning, contact Grayhill.

Insertable Legend Styles

Prototypes can look professional with insertable legend modules. Just slip imprinted legend insert through the slot of the clear button cap.

Legend Sheet

Available for each module style. Each sheet contains commonly used symbols, terms, alpha characters, and 0-19 in News Gothic Condensed type on polyester film, ready to be cut and inserted. Deadfront legends are invisible until lit.



White on Clear—For unlighted gray modules

Black on Clear—For lighted gray modules

Translucent White on Black—For black modules

Deadfront on Black—For black modules

Part No. 82AC2017-1

Part No. 82AC2050-1

Part No. 82AC2055

Part No. 82AC2060

SPECIAL LEGENDS

Molded-In Legends

For Unlighted Modules

In addition to standard white legend on gray button, longwearing, molded-in legends are available in white button with black legend and white legend with red, green or black buttons. Other color combinations are possible.



Printed Legends

In 2 Styles

Virtually anything which can be photographed can be printed. Sturdy epoxy ink printing bonds to the surface of the button. Standard printing for the gray unlighted buttons is white; standard printing for the translucent white buttons of the lightable modules is black.

Top Surface Printing—Legend is applied directly to top of button. Available on all standard, unlighted modules.

Sub Surface Printing—Provides maximum wear for printed surfaces. Available for lighted and unlighted gray modules. Printed internal button cap is protected by a clear outer cap.

Printed Typestyles

The typestyle chart below illustrates type style and approximate sizes and limits for button cap legends; other sizes are also available. Limitations for legends differ with type size and character. Legends for lightable modules are further limited by the size of the internal button and lighted area. Grayhill's library includes many popular legends. Contact Grayhill for complete information.

Special Colors

Besides the standard gray and black housings, you may order white, beige or brown. Button colors may also be specially ordered. For more information, see next page.



Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations	Top Surface Character and Line Limitations	Lightable Module Character and Line Limitations*
4GH088 .083"	ABCDEFGH	5 Char. 2 Lines TAB INDEX	8 Char. 3 Lines RESEARCH SYSTEMS 12345678	4 Char. 2 Lines STOP 1234
1GH125 .138"	ABCDE	4 Char. 1 Line OPER	4 Char. 2 Lines CODE SEND	3 Char. 1 Line OFF
3GH187 .207"	ABCD	2 Char. 1 Line ON	3 Char. 1 Line OFF	2 Char. 1 Line ON
2GH250 .276"	ABC	2 Char. 1 Line 15	2 Char. 1 Line 15	N/A N/A

Note: Limitations for legends differ with surface to be printed and actual characters. If your application exceeds the approximations in the chart, contact Grayhill for more information.

* For top and sub-surface printed modules.

KEYBOARD MODULES

ORDERING INFORMATION—Standard Modules

Type of Module	Description	Part No.
Top Half of Telephone Legend (Molded-in)	6 Buttons, SPST	82-601-85
	6 Buttons, 2PST	82-601-86
	6 Buttons, 3PST	82-601-87
	6 Buttons, 4PST	82-601-88
Bottom of Telephone Legend (Molded-in)	6 Buttons, SPST	82-601-89
	6 Buttons, 2PST	82-601-90
	6 Buttons, 3PST	82-601-91
	6 Buttons, 4PST	82-601-92
Unlighted Gray Modules For Legend Inserts	1 Button, SPST	82-101-71
	1 Button, 4PST	82-101-74
	2 Buttons, SPST	82-201-41
	2 Buttons, 4PST	82-201-44
	3 Buttons, SPST	82-301-61
	3 Buttons, 4PST	82-301-64
	6 Buttons, SPST	82-601-81
	6 Buttons, 4PST	82-601-84
Lightable Gray Modules Non-Legend	1 Button, SPST	82-150-17
	1 Button, 2PST	82-150-15
	3 Buttons, SPST	82-350-10
	3 Buttons, 2PST	82-350-8
Lightable Gray Modules For Legend Inserts	6 Buttons, SPST	82-650-10
	6 Buttons, 2PST	82-650-8
	1 Button, SPST	82-150-38
	1 Button, 2PST	82-150-16
	3 Buttons, SPST	82-350-12
	3 Buttons, 2PST	82-350-9
Lightable Black Modules For Legend Inserts	6 Buttons, SPST	82-650-19
	6 Buttons, 2PST	82-650-9
	1 Button, SPST	82-150-211
	1 Button, 2PST	82-150-213
	3 Buttons, SPST	82-350-41
	3 Buttons, 2PST	82-350-43
Legend Sheets	6 Buttons, SPST	82-650-71
	6 Buttons, 2PST	82-650-73
	White—For Unlighted Gray	82AC2017-1
	Black—For Lightable Gray	82AC2050-1
	Clear—For Lightable Black	82AC2055
	Deadfront—For Lightable Black	82AC2060

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ORDERING INFORMATION—Special Legends

To order non-standard modules, information is required for the areas listed below.

Your special order will be assigned a part number for future identification. This number is sequentially assigned and is non-descriptive.

1. Type of Module. Unlighted: 1-, 2-, 3-, or 6-button. Lightable: 1-, 3-, or 6-button.

2. Mounting Orientation. Horizontal or vertical.

3. Circuitry. Requirements for each button must be listed by its reference letter designation. For example: Button A = SPST, Button B = 4PST, Button C = 3PST, etc. For coded or other available circuitry patterns a descriptive diagram is required for each button.

4. Button Type (Legend). Grayhill offers four legend types: molded-in; top surface printed; sub-surface printed; and insertable. Unlighted modules are available in all types. Lightable modules are available in all types but molded-in legends.

Button Color. Standard color for molded-in legend modules is gray button with white legend. Special button colors available are white with black legends, red, green or black buttons with white legends. Additional custom colors are available by special order.

Lightable gray modules have a standard translucent white button with black legend. Special button color includes translucent red, amber, yellow, blue and green. Lightable black modules have a special opaque black button; discuss special colors with Grayhill.

Colors can be intermixed, ie. buttons A-E gray; and F, white.

5. Housing Color. Base in black. Upper housing is black for lightable legends and gray for all other module styles. Other stock colors available include white, beige and brown.

6. Legends. List legend requirement for each button (Button A legend, "10", is type style 4GH088. Button B, "ON", is type style 1GH125, etc.). For legend information, see page C-38.

Price—Contact Grayhill

SERIES 87

Design Keyboards and Individual Keyswitches to Virtually any Configuration Without Costly Tooling

FEATURES

- 1, 2, 3, 4, 5 and 6 Button Individual Keyswitches
- 12 and 16 Button Keypads
- Maintain 1/2" Button Centers, no Matter How You Mount Modules or What Combination You Use
- Up to 3,000,000 Operations per Button
- Low Profile Design

Legends For Any Need

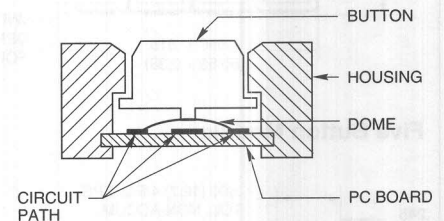
Prototypes and small quantities—create your own with economical, insertable legend style modules.

Production quantities—choose either custom printing or permanent molded-in legends.

Snap Dome Contact System

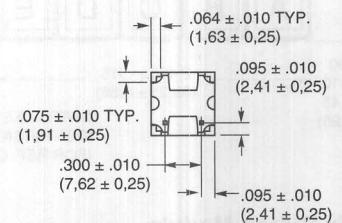
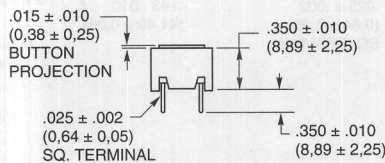
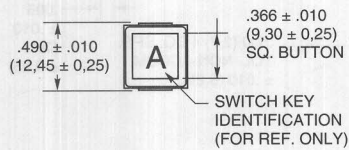
Hear and feel button actuation

You're assured of reliable button actuation with the metal snap-dome under each Series 87 button. When actuated, the dome changes shape, providing audible and tactile feedback to the operator.

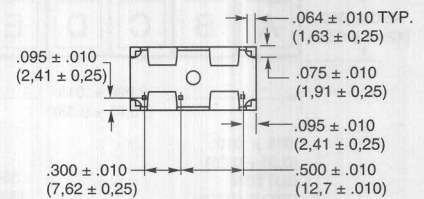
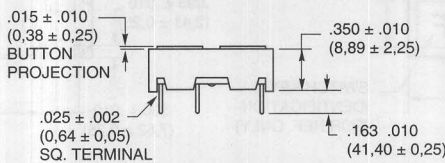
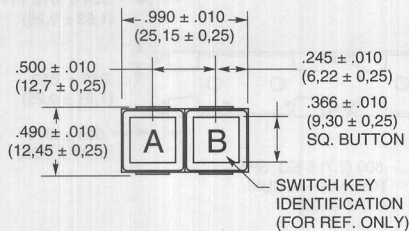


DIMENSIONS In inches (and millimeters)

One Button Module



Two Button Module

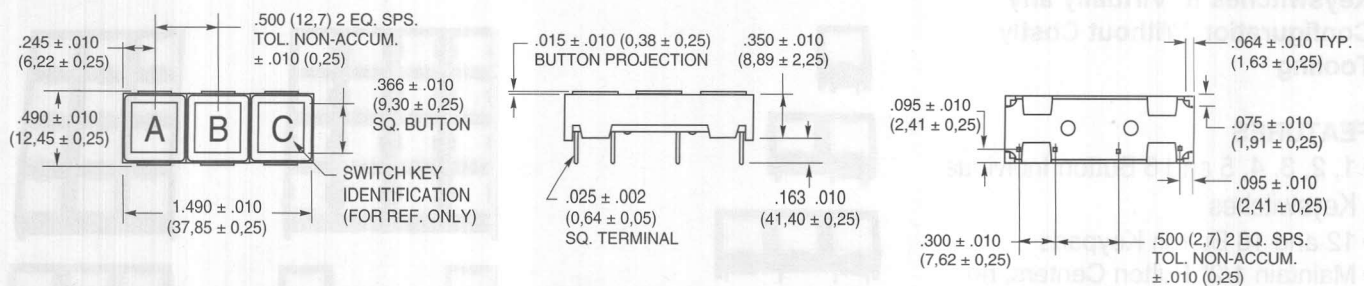


See pages C-41 through C-44 for dimensions of other modules, specifications and ordering information.

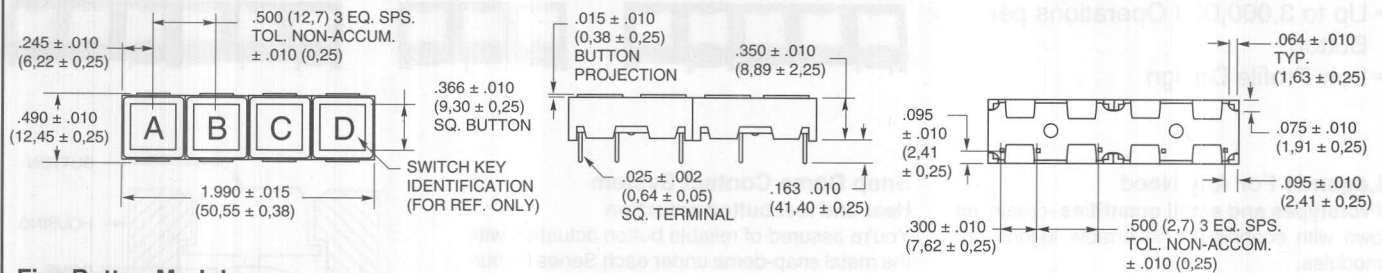
KEYBOARD MODULES

DIMENSIONS In inches (and millimeters)

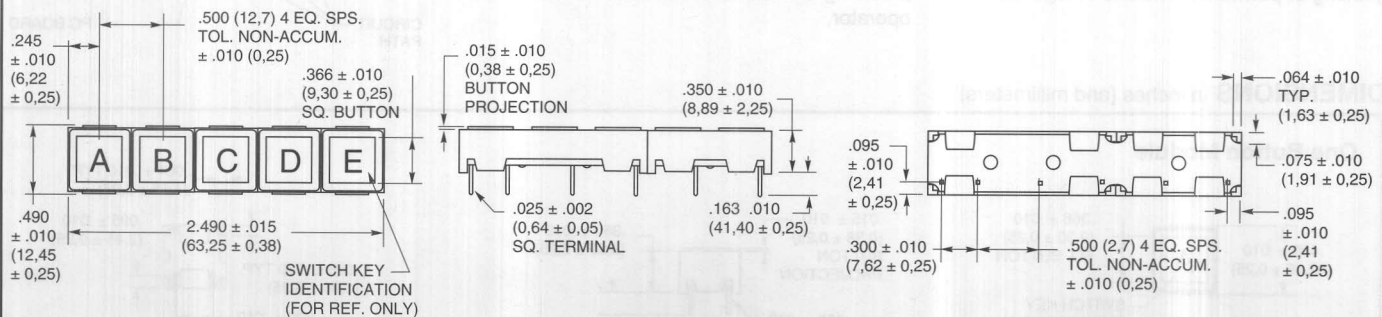
Three Button Module



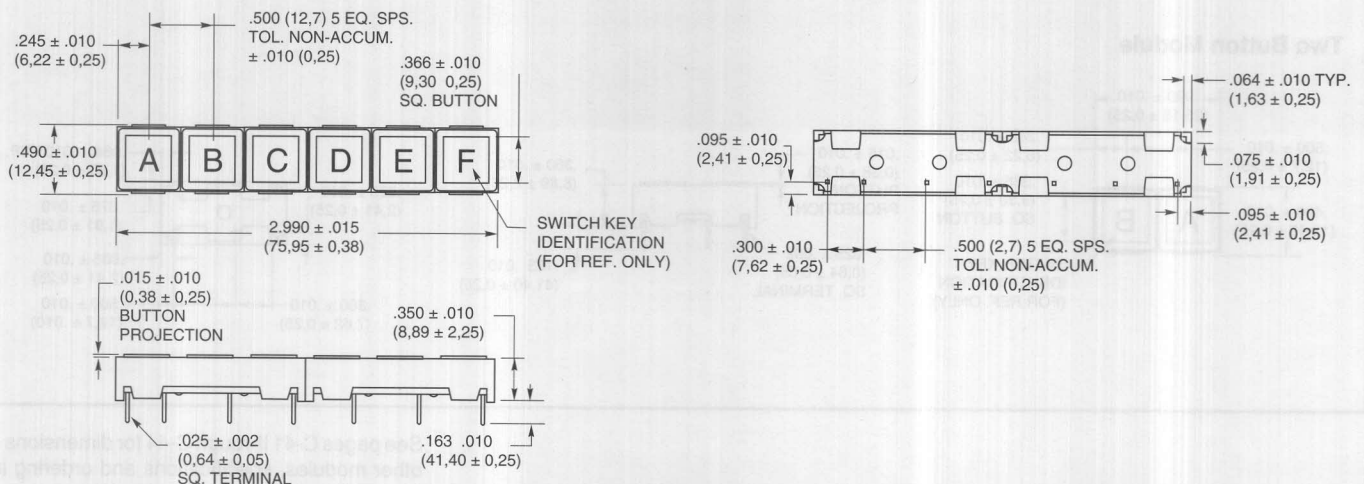
Four Button Module



Five Button Module



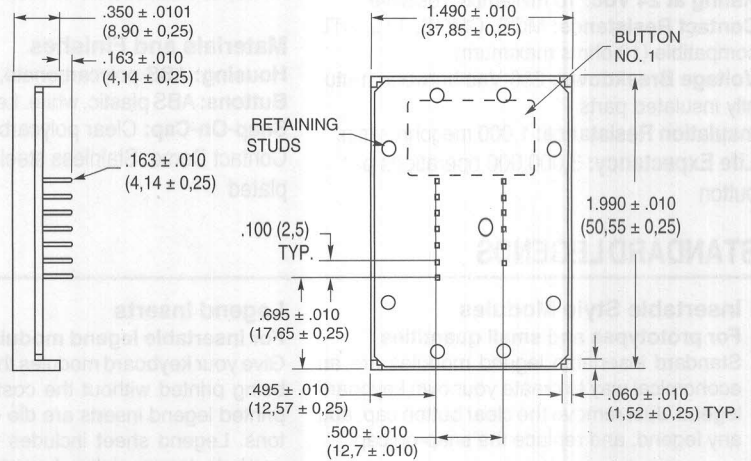
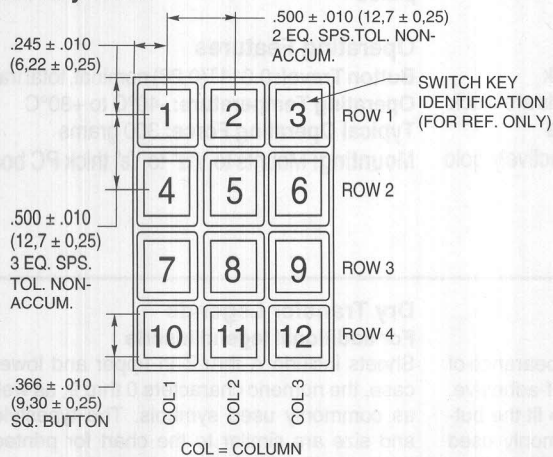
Six Button Module



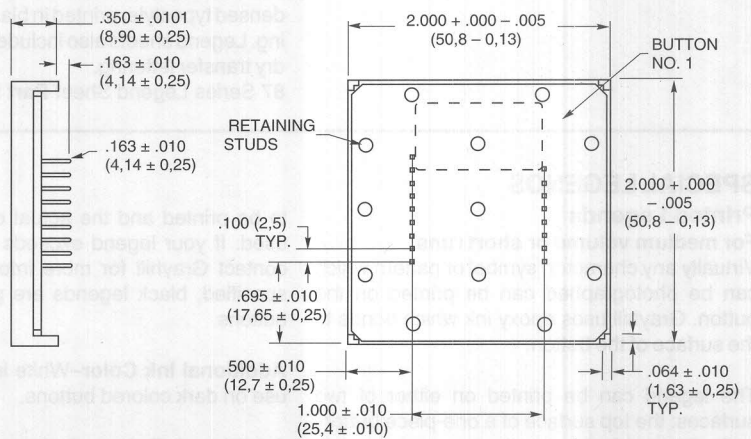
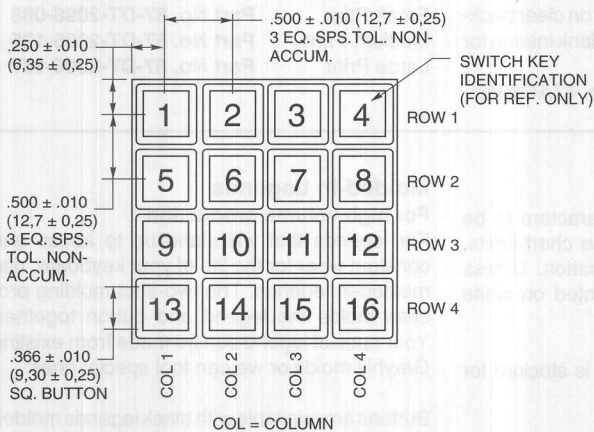
See page C-43 to C-44 for specifications, legends and ordering information.

DIMENSIONS In inches (and millimeters)

3x4 Keyboard



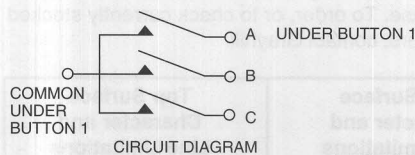
4x4 Keyboard



CIRCUITRY, CODE AND TRUTH TABLES

Circuitry for Module Strips

The one-button thru six-button modules have single pole/common bus circuitry as shown in the circuit diagram. The common is located at the far right end under button one as shown in the rear view drawing; it is not marked on the actual product.



Code and Truth Table

Dots in the chart indicate connected terminals when switch is closed. Terminals are identified on the keyboard.

3x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
	K D E B C L M	K H A J C B M E F L N G D
	TERMINAL LOCATION	

4x4	CODES	
	Matrix	Single Pole/Common Bus
BUTTON LOCATION	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
	M N G F D E P Q	K N B A L M D C Q P F G S R E H J
	TERMINAL LOCATION	

See page C-43 to C-44 for specifications, legends and ordering information.

KEYBOARD MODULES

SPECIFICATIONS

Rating

Rating at 24 Vdc: 10 milliamps, resistive

Contact Resistance: MOS, CMOS, TTL, DTL compatible (10 ohms maximum)

Voltage Breakdown: 250 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms min.

Life Expectancy: 3,000,000 operations per button

Contact Bounce: Less than 4 milliseconds at make, 10 milliseconds at break

Materials and Finishes

Housing: ABS polycarbonate, black

Buttons: ABS plastic, white. Legends are black.

Snap-On-Cap: Clear polycarbonate

Contact Dome: Stainless steel, selectively gold plated

Terminals: Copper alloy, CDA 725, tin-lead plated

Operating Features

Button Travel: 0.011" (0,28) nominal, total travel

Operating Temperature: -40°C to +80°C

Typical Operating Force: 300 grams

Mounting: Mounts to 1/32" to 1/8" thick PC board

STANDARD LEGENDS

Insertable Style Modules

For prototypes and small quantities

Standard insertable legend modules are an economical way to create your own keyboard legend. Just remove the clear button cap, add any legend, and replace the snap-on cap.

Legend Inserts

For insertable legend modules

Give your keyboard modules the appearance of being printed without the cost. Self-adhesive, printed legend inserts are die cut to fit the buttons. Legend sheet includes commonly used symbols, terms, alpha characters A-Z, and numeric characters 0-99 in News Gothic Condensed typestyle, printed in black on clear backing. Legend sheets also include blank inserts for dry transfer lettering.

87 Series Legend Sheet **Part No. 87AC2046**

Dry Transfer Legends

For additional legend inserts

Sheets include A thru Z in upper and lower case, the numeric characters 0 thru 9, as well as commonly used symbols. The typestyle and size are similar to the chart for printed legends shown below.

Small Print

Medium Print

Large Print

Part No. 87-DT-2096-088

Part No. 87-DT-2096-125

Part No. 87-DT-2096-187

SPECIAL LEGENDS

Printed Legends

For medium volume or short runs

Virtually any character, symbol or pattern which can be photographed can be printed on the button. Grayhill uses epoxy ink which bonds to the surface of the button.

The legend can be printed on either of two surfaces: the top surface of a one-piece button, or the internal surface on the snap-on cap style for maximum wear.

The typestyle chart shows the style and the approximate limitations of Grayhill's standard type. However, limitations differ with the surface

to be printed and the actual characters to be used. If your legend exceeds the chart limits, contact Grayhill for more information. Unless specified, black legends are printed on white buttons.

Additional Ink Color—White ink is stocked for use on dark colored buttons.

Additional Button Colors—For a molding charge, we can provide buttons from other colors which we may have in stock, such as black, red, green, blue, or yellow. Non-stock button/ink colors may require minimum material purchase. To order, or to check currently stocked colors, contact Grayhill.

Molded-in Legends

For high volume production

For legends that will stand up to abuse and constant wear for the life of your keyboard, use molded-in legends. The two-shot molding process molds the legend and button together. Your special legend can be made from existing Grayhill molds or we can tool special ones.

Buttons are available with black legends molded in white or other light backgrounds, or with white legends molded into dark backgrounds. See Printed Buttons, Additional Button Colors. To order, contact Grayhill.

Type No. and Typical Height	Sample Style and Typical Sizes	Sub Surface Character and Line Limitations		Top Surface Character and Line Limitations	
4GH088 .083"	ABCDEFGH	4 Characters 2 Lines	END DATA	4 Characters 2 Lines	END DATA
1GH125 .138"	ABCDE	3 Characters 1 Line	LAD	3 Characters 1 Line	LAD
3GH187 .207"	ABCD	2 Characters 1 Line	ON	2 Characters 1 Line	ON
2GH250 .276"	ABC	N/A	N/A	2 Characters 1 Line	15

ORDERING INFORMATION

Type of Module or Legend	Part Number
1 Button	87CC3-201
2 Button	87DC3-201
3 Button	87EC3-201
4 Button	87FC3-201
5 Button	87GC3-201
6 Button	87HC3-201
12 Button—Matrix	87AB3-201
12 Button—SP/Com Bus	87AC3-201
16 Button—Matrix	87BB3-201
16 Button—SP/Com Bus	87BC3-201
Insertable Legend Card	87AC2046
Dry Transfer—Small	87-DT-2096-088
Dry Transfer—Medium	87-DT-2096-125
Dry Transfer—Large	87-DT-2096-187

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ORDERING INFORMATION— Special Legends

To order non-standard modules, information is required for the areas listed below.

Your special order will be assigned a part number for future identification. This number is sequentially assigned and is non-descriptive.

- 1. Type of Module.** 1, 2, 3, 4, 5, 6, 12 or 16 button.
- 2. Mounting Orientation.** Horizontal or vertical.
- 3. Circuitry.** Single pole/common bus is standard for all single row modules. For 12 or 16 button keyboard, specify single pole/common bus or matrix.
- 4. Housing Color.** Standard housing is black. Optional stock colors include beige and gray.

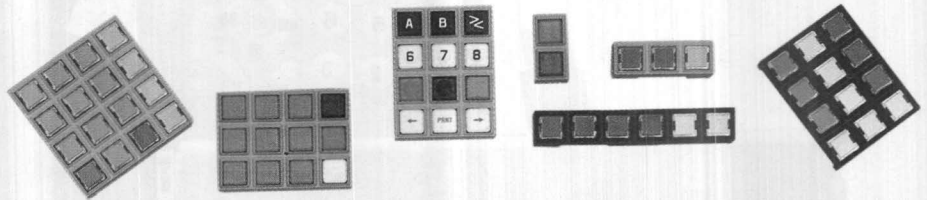
- 5. Button Types.** Flat or concave buttons are available for molded legends; flat, concave, and snap-on cap styles are available for printed legends.

- 6. Button Color.** Standard buttons for molded and printed legends are white with black legend. Other colors available include white legends with red, green, dark blue, dark gray and black buttons, or black legends with yellow, blue, light gray, beige and white buttons. Additional legend colors such as red are also available.

- 7. Legend Style.** Two-shot molded or printed. Printed legends may be top or sub-surface printed.

- 8. Actual Legend.** Specify for each button using the button identification on drawings.

Price—Contact Grayhill



Special Legends

CUSTOM KEYBOARDS

COMMERCIAL KEYBOARDS

FEATURES

- Snap Dome or Conductive Rubber
- Low Profile Keypads
- Custom Graphics, Legends and Embossing
- Custom Housing and Buttons
- EMI/RFI Shielding
- Special Circuitry
- Custom Terminations
- Special Mountings
- Integrated Electronic Assemblies:
LED's, Displays
- Keyboards with Assembled
Decoder Electronics
- Custom Illumination
- Backlighting



Front panel assembly for the Motorola R-2600 Communications Systems Analyzer

Grayhill is strategically set up to consolidate standard keypad assembly with your specific keyboard requirements, including attachments, to generate a total keyboard solution. The engineering division, tooling department, mold-

ing facility, and assembly departments are fully integrated to assure a systematic transfer of customer requirements and specifications. This enables us to minimize the risk for errors and maximize response time. At Grayhill, no request is too special.

Grayhill has the ability required to accurately assemble thru-hole and surface mount components. Our on-line SPC system ensures a properly manufactured assembly.

MILITARY KEYBOARDS

FEATURES

- Snap Dome Technology
- Custom Illumination
- Custom Bezels
- In-House Machining Capabilities
- Unique Electronic Configurations
- NVG Compatible Backlighting
- Sealed and Submersible
- EMI/RFI Shielded Windows

MIL Specs such as: MIL-STD-105, 202, 285,
810, 1285, 45662, 595, 454



- 4PST Joystick Action
- Space Saving Miniature Sizes
- Bushing or Bezel Mounting

Page

ENGINEERING INFORMATION D-3

SELECTION D-4

SPACE SAVING BUTT CONTACT PUSHBUTTON SWITCHES

Miniature Alternate Action	Series 38	D-5
Miniature Surface Mount	Series 38	D-6
Miniature Horizontal PC Mount	Series 38	D-7
Miniature Vertical PC Mount	Series 38	D-8
Miniature PC Mount	Series 32 & 39	D-9
Miniature Limit	Series 39	D-14
150 mA to 1/2 Amp, SPST	Series 39	D-15
1 and 5 Amp, SPST, Small, UL	Series 30	D-17

LOW RESISTANCE WIPING CONTACT PUSHBUTTON SWITCHES

1/4 Amp, SPDT and DPDT Long Wipe	Series 46	D-21
1/4 Amp, SPST Small	Series 23	D-24
1 and 3 Amp, SPST, UL	Series 10 & 4000	D-25

ATTRACTIVE BEZEL MOUNTED PUSHBUTTON SWITCHES

Snap-In Panel Mount Switches	Series 30 & 46	D-26
Decorator Line Switches	Series 30 & 46	D-28

HIGH CURRENT SNAP ACTION CONTACT PUSHBUTTON SWITCHES

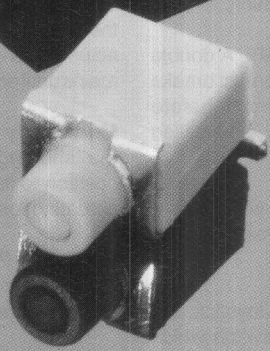
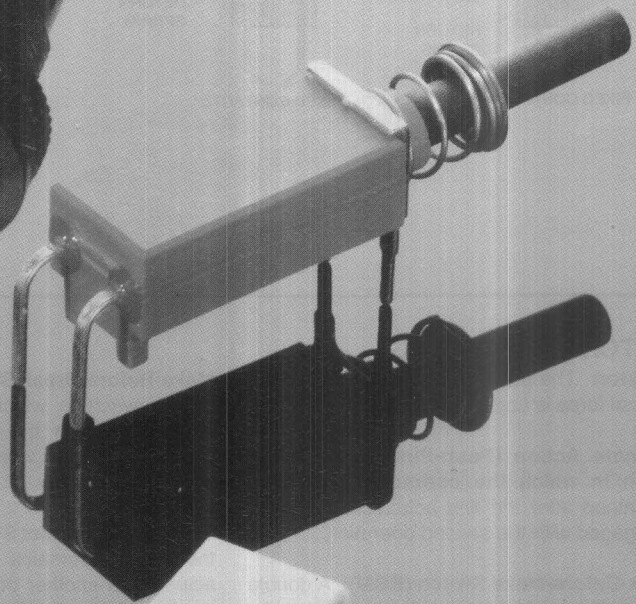
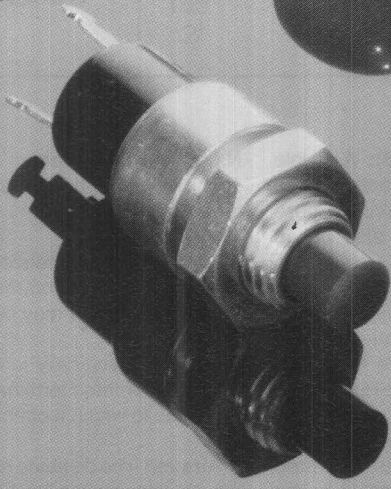
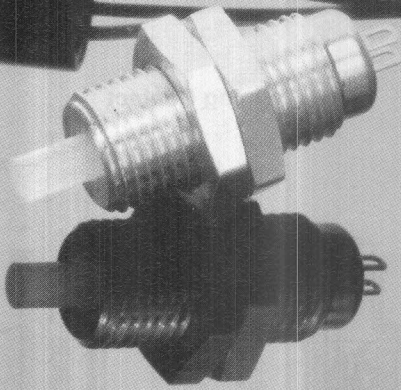
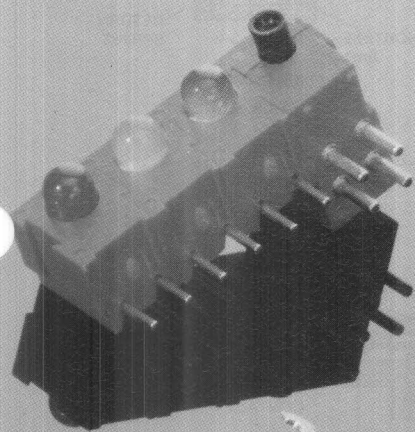
10 Amps, SPST and SPDT	Series 7 & 2000	D-31
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JOYSTICK ACTION PUSHBUTTON SWITCH

Contact in Each of Four Directions	Series 4	D-32
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OPTIONS AND ACCESSORIES

Sealed Terminals and Wire Leads	Series 23, 30, 39 & 46 ..	D-33
Accessories		D-34



Ratings, operating environments and switch selection are discussed in detail on pages E-3 thru E-5. This information is applicable to pushbutton switches as well as rotary and DIP switches.

Pushbutton switches are selected not only by their ratings, but also by their contact type. While nearly all rotary switches and DIP switches have wiping contacts, pushbutton switches may have either wiping or butt contacts (see internal views below).

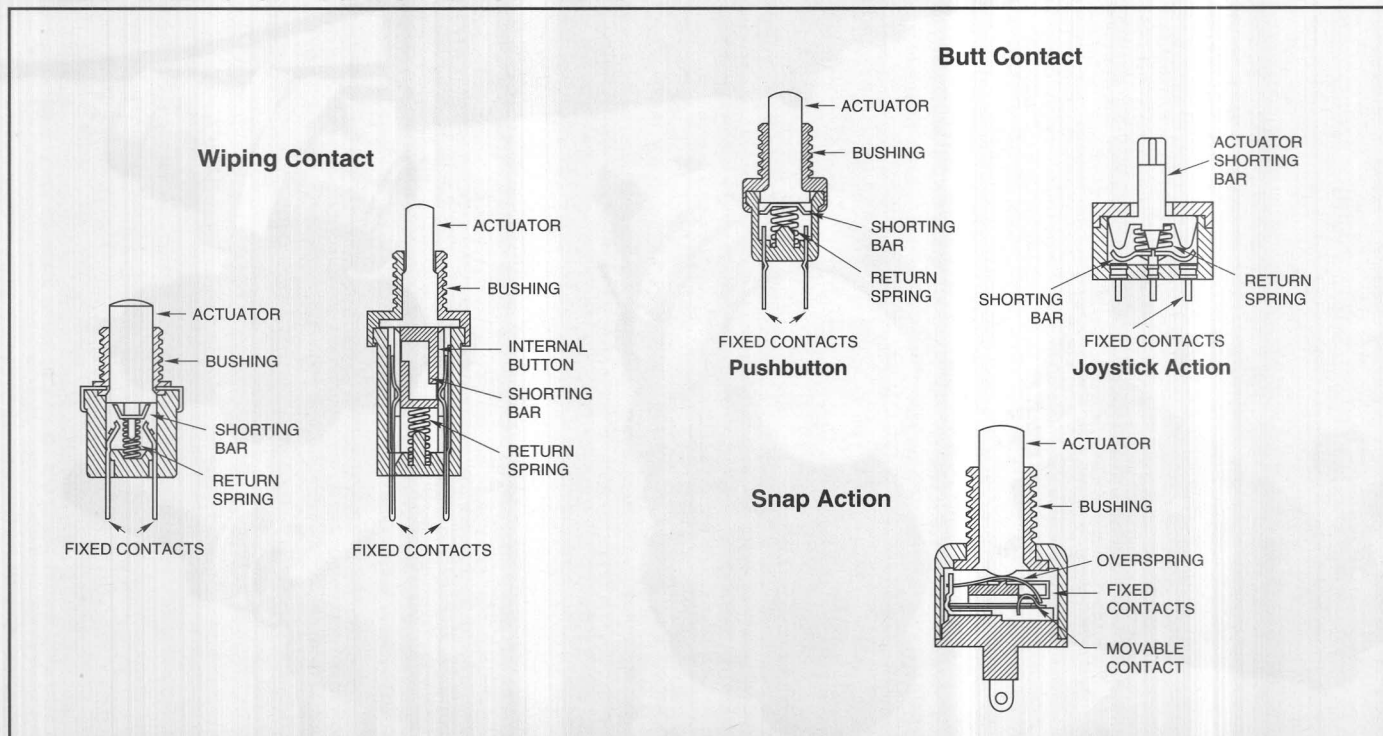
Wiping Contacts are self-cleaning and usually provide a low resistance in circuits where contact resistance is critical. However, the wiping action creates mechanical wear and conductive wear products.

Butt Contacts have less wear than wiping contacts and therefore, have a longer life. They are also smaller. Butt contacts are not self-cleaning, so their contact resistance can vary from operation to operation.

Snap Action switches are basically butt contact switches with a spring mechanism which provides the make and break. The mechanism controls both the operating point and the rate of operation, but adds to the wear of the switch.

The rapid rate of make and break means that these switches are appropriate for high current loads. They usually have a slight wiping action and contact surfaces made of precious metals to minimize their disadvantages.

INTERNAL VIEWS OF PUSHBUTTON SWITCHES



SWITCH TERMINOLOGY

Actuator: The part of the switch to which an external force is applied to operate the switch.

Alternate Action (Push-Push) Switch: A switch in which the operable position is maintained after the first actuation, and then disengaged with the second operation.

Break-Before-Make Switch (BBM): A double throw switch in which the moving contact breaks the connection with the first circuit before making contact with the second; also called non-shorting switch.

Double Throw Switch: A switch which has a normally open as well as a normally closed circuit per pole.

Joystick Action Switch: (From Joystick, the control for an airplane). A lever switch which operates with momentary action in 4 directions, and is disengaged in the upright position.

Make-Before-Break Switch (MBB): A double throw switch in which the contacts makes connection with the second circuit before breaking contact with the first; also called shorting switch.

Maintained Contact Switch: A switch in which the actuator remains in a position until it is actuated to another position where it also remains until actuated. Example: Push-Pull Switch.

Momentary Contact Switch: A switch in which the shorting bar returns from its operated position to its normal or free position when the actuating force is removed.

Operating Position or Point: The position of the actuator when the desired electrical action (make or break of contact) occurs.

N.C., Normally Closed: Switch in which the circuit is closed without actuation (with actuator in the "normal" position).

N.O., Normally Open: Switch in which the circuit is open without actuation (with actuator in the "normal" position).

Overtravel: The distance or angle between the operating position and the extreme position to which the actuator may be moved.

Pole: An electrically isolated circuit within a switch; a common terminal and all the selected terminals to which it connects.

Pretravel: The distance or angle through which the actuator moves from its free position to its electrical operating position.

Single Throw Switch: A switch which has only one normally open or one normally closed circuit per pole.

Throw: See Single Throw and Double Throw.

SELECTOR CHARTS

Circuitry*	Rating (Amps at 115 Vac Res.)	Operations At Rating	Max. Width*** in. (mm)	Features	Series	Page
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WIPING CONTACT SWITCHES-PUSHBUTTON

SPST	N.O. or N.C.	3	6,000	13/16 (20,6)	UL Listed	4000/10	D-25
	N.O. or N.C.	1	100,000	13/16 (20,6)	Momentary Action & Positive Feel Types	4000/10	D-25
	N.O.	.250	100,000	1/2 (12,7)	Momentary Action & Terminal Seal Types	23	D-24
SPDT	BBM or MBB	.250	250,000	7/16 (11,11)	Momentary Action	46	D-21
	BBM or MBB	.250	250,000	1+ (25,4+)	Square Bezel Panel Mount	46	D-26
	BBM or MBB	.250	100,000	1/2 (12,7)	Watertight Seal	46	D-22
	BBM	.250	250,000	11/16 (17,46)	Square & Round Bezels	46	D-28+
	BBM	.250	250,000	11/16 (17,46)	Alternate Action, Square & Round Bezels	46	D-28+
	BBM	.250	250,000	1+ (25,4+)	Alternate Action, Square Bezel Panel Mount	46	D-26
DPDT	BBM or MBB	.250	100,000	5/8 (15,88)	Momentary Action	46	D-21
	BBM	.250	250,000	13/16 (20,6)	Environmental Seal/Wire Leads	46	D-23
	BBM or MBB	.250	100,000	11/16 (17,46)	Watertight Seal	46	D-23
	BBM	.250	250,000	11/16 (17,46)	Square & Round Bezel & Positive Feel Types	46	D-28+
	BBM	.250	250,000	11/16 (17,46)	Alternate Action, Square & Round Bezels	46	D-28+
	BBM or MBB	.250	250,000	1+ (25,4+)	Alternate Action, Square Bezel Panel Mount	46	D-26

BUTT CONTACT SWITCHES-PUSHBUTTON

SPST	N.O. or N.C.	5	6,000	3/8 (9,53)	UL Listed	30	D-17+
	N.O. or N.C.	1	1,000,000	3/8 (9,53)	Momentary, Terminal Seal, (Wire Leads Optnl.)	30	D-17+
	N.O.	1	500,000	3/8 (9,53)	Overtravel, Terminal Seal, (Wire Leads Optnl.)	30	D-19
	N.O.	1	200,000	11/16 (17,46)	Positive Feel, Overtravel, Terminal Seal, (Wire Leads Optional)	30	D-19
	On or Off	1	100,000	11/16 (17,46)	Push/Pull Action (Maintained)	30	D-19
	N.O. or N.C.	1	250,000	1/2 (12,7)	Watertight, Terminal Seal, (Wire Leads Optnl.)	30	D-18
	N.O.	1	1,000,000	11/16 (17,46)	Square & Round Bezels	30	D-28+
	N.O. or N.C.	1	1,000,000	1+ (25,4)	Square Bezel Panel Mount	30	D-26
	N.O.	1	200,000	11/16 (17,46)	Pos. Feel, Overtravel, Square & Round Bezels	30	D-28+
	N.O.	1	200,000	11/16 (17,46)	Pos. Feel, Overtravel, Sq. Bezel Panel Mount	30	D-26
	On/Off	1**	25,000	3/8 (9,53)	PC Board Edge Mount, Push On, Push Off	38	D-5
	N.O.	.020**	80,000	5/16+ (8,13)	Miniature, Surface Mount	38	D-6
	N.O.	.020**	80,000	5/16+ (8,13)	Miniature, Right Angle to PC Board	38	D-7
	N.O.	.020**	80,000	5/16+ (8,13)	Miniature, Vertical to PC Board	38	D-8
	N.O. or N.C.	.250	100,000	1/4 (6,35)	Right Angle, PC Mount, 2 Circuits, Process Sealed. Interlocks with Adjacent Switch or LED	32	D-9
	N.O.	.500	1,000,000	1/4 (6,35)	Miniature	39	D-15
	N.O.	.500	500,000	1/2 (12,7)	Overtravel, Miniature Limit Switch, (Wire Leads Optional)	39	D-14
	N.O.	.500	100,000	1/2 (12,7)	Overtravel, Miniature, (Wire Leads Optional)	39	D-15
	N.O.	.500	250,000	5/16 (7,94)	Watertight Seal, Miniature, (Wire Leads Optional)	39	D-15
	N.C.	.250	250,000	1/4 (6,35)	Miniature (Wire Leads Optional)	39	D-16
	N.C.	.250	100,000	5/16 (7,94)	Watertight Seal, Miniature, (Wire Leads Optnl.)	39	D-16
	N.C.	.250	100,000	1/2 (12,7)	Actuator Seal, Miniature Limit Switch (Wire Leads Optional)	39	D-14
	N.O.	.150**	1,000,000	1/4 (6,35)	PC Mount, Miniature, Sealed	39	D-12
	N.O.	.150**	1,000,000	1/4 (6,35)	PC Mount, Miniature, Right Angle, Cap Seal	39	D-13
	N.O.	.150**	100,000	1/4 (6,35)	PC Mount, Miniature, Overtravel	39	D-12
	N.O.	.020, .150**	1,000,000	3/8 (9,53)	Economical Contact Plating	30	D-17
	N.O.	.020, .150**	1,000,000	3/8 (9,53)	Econ. Plating, Square Bezel Panel Mount	30	D-26
	N.O.	.020, .150**	1,000,000	1/4 (6,35)	Economical Contact Plating	39	D-15
	N.O.	.020, .150**	100,000	1/2 (12,7)	Actuator Seal, Overtravel, Miniature Limit Switch, (Wire Leads Optional)	39	D-14
SPDT	BBM	.250	100,000	1/4 (6,35)	Right Angle, PC Mount, 2 Circuits, Process Sealed. Interlocks with Adjacent Switch or LED	32	D-9
	BBM	.250	500,000	1/2 (12,7)	PC Mount, 2 Circuits, Right Angle, Total Seal	39	D-11

SNAP ACTION SWITCHES-PUSHBUTTON

SPST	N.O. or N.C.	10	25,000	7/8 (22,23)	Faston Terminals, Audible Click	2000/7	D-31
SPDT	BBM	10	25,000	7/8 (22,23)	Audible Click	2000/7	D-31

BUTT CONTACT SWITCHES-JOYSTICK ACTION

4PST	BBM	.250	500,000	7/8 (22,23)	4-Way Action, 3 Actuator Choices	4	D-32
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* BBM is Break-Before-Make (Non-Shorting). MBB is Make-Before-Break (Shorting).

** Rated for 28 Vdc and/or 5 Vdc (.150 A) and 20 Vdc (.020 A).

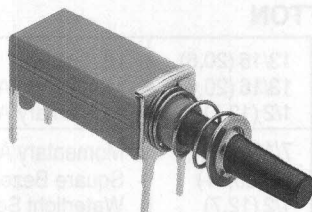
*** Maximum width behind panel or above PC board rounded to next highest 1/16" (1,59 mm).

MINIATURE ALTERNATE ACTION PUSHBUTTON SWITCH

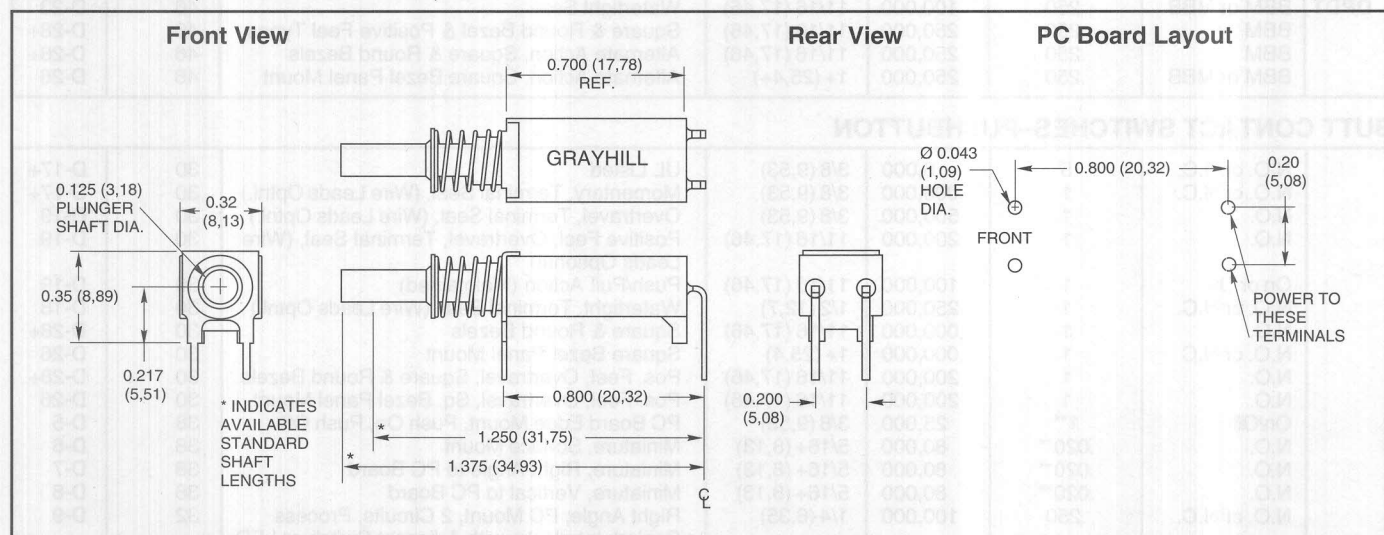
SERIES 38

FEATURES

- Alternate Action
- Process Compatibility
- Sealed Plunger Option
- 25,000 Operations
- Choice of Shaft Lengths
- PC Mount
- Momentary Version Available



DIMENSIONS (In inches and millimeters)



SPECIFICATIONS

Electrical Ratings

Operating Life: 25,000 operations, 1 amp at 28 Vdc, silver contact system; 25,000 operations, 0.2 amps at 30 Vdc, gold contact system.

Initial Contact Resistance: <30 milliohm initial/100 milliohm max.

Insulation Resistance: 1,000 megaohm

Voltage Breakdown: 1000 V RMS min @ sea level

Solderability: Per MIL-STD-202F Method 208D, or EIA RS-186E Method 9 (1 hour steam aging)

Operating Features

Operation Mode: Latching (self locking)

Terminal Style: PC mounting

Total Travel: 0.150 in (3,8 mm)

Travel (ON/OFF distance): 0.098 in (2,5 mm)

Operating Force: 3 +/- 1.5 N (306 +/- 153 gf)

Operating Temperature: -30 °C to 85 °C

Additional Characteristics

Number of Poles: 1

Number of Positions: 2

Lever Center Height: 0.217 in (5,5 mm)

Materials and Finishes

Plunger: Polyphenylene sulfide

Base and Cover: Thermoplastic polyester

Contact System: Copper alloy, with gold or silver plate

Terminals: Tin lead plate

Retaining Ring: Stainless steel

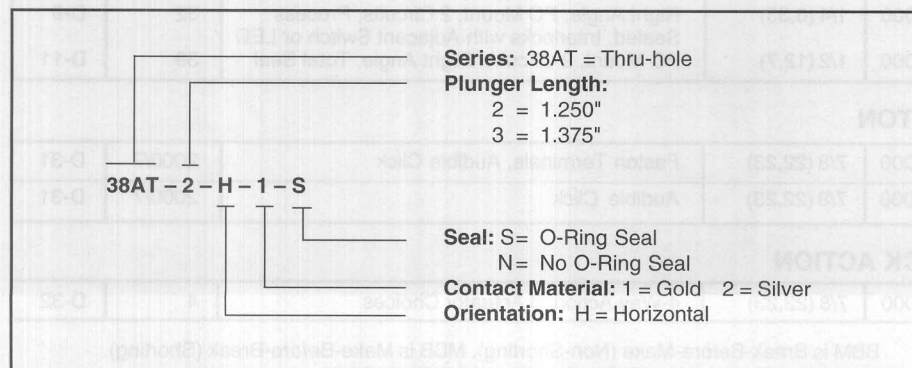
Outer Spring: Stainless steel

Inner Spring: Plated music wire

Switch Support: Brass, tin plated

Terminal Seal: Epoxy

ORDERING INFORMATION



Available from your local Grayhill Distributor

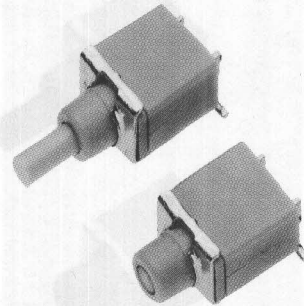
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MINIATURE SURFACE MOUNT PUSHBUTTON SWITCH

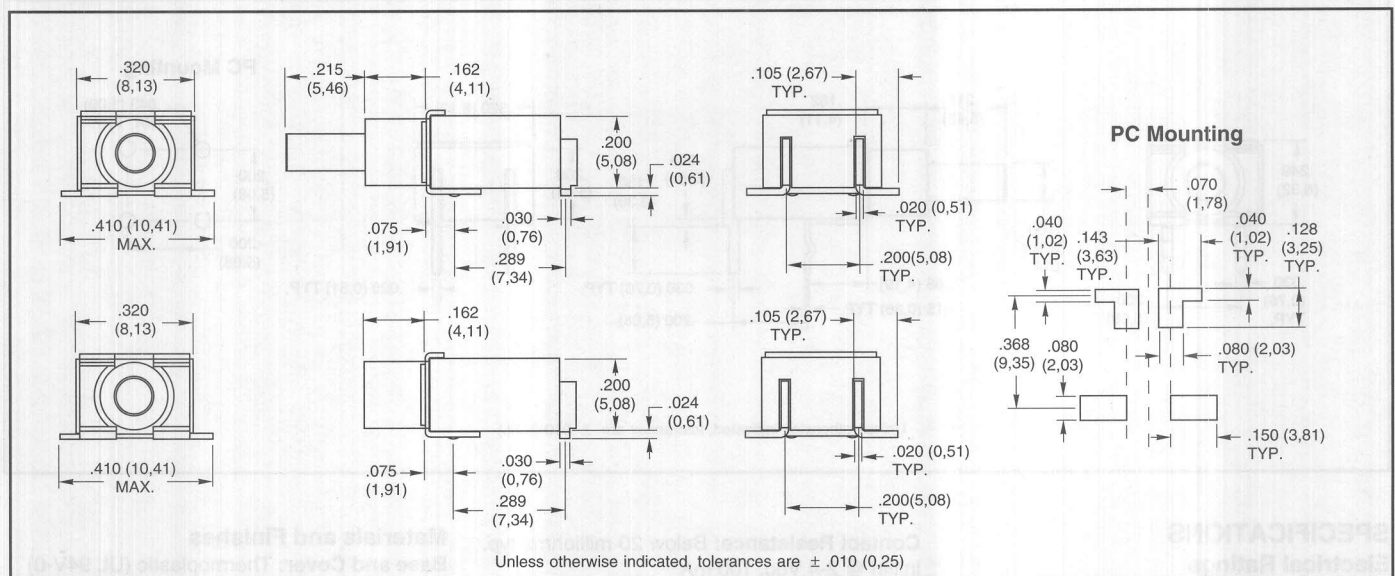
SERIES 38

FEATURES

- Surface Mount Process Compatible
- Sealed Construction
- Terminal Solder Coat
- SPST, Momentary Contact
- Extended or Flush Plunger
- Drop-In Replacement for Industry Standard



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Electrical Ratings

Operating Life: 80,000 make-and-break cycles @ full load

Contact Rating (resistive load):

Gold Contacts: 0.4 VA max. @ 20 Vac or Vdc max.

Contact Resistance: Below 20 milliohms typ. initial @ 2-4 Vdc, 100 mA

Insulation Resistance: 1000 megaohms min.

Voltage Breakdown: 1000 V RMS minimum @ sea level

Operating Temperature: -30°C to +85°C

Solderability: Per MIL-STD-202F, Method 208D, or EIA RS-186E Method 9 (1 hour steam aging)

Materials and Finishes

Base and Cover: Thermoplastic (UL 94V-0)

Plunger: Thermoplastic (UL 94V-0), with standard internal O-ring seal

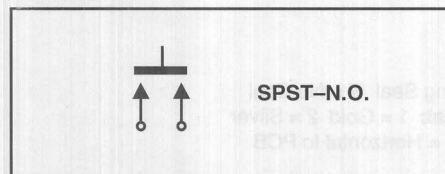
Terminals: Copper alloy, solder plate over nickel plate

Spring: Plated Music Wire

Contact System: Copper alloy, gold plate over nickel plate

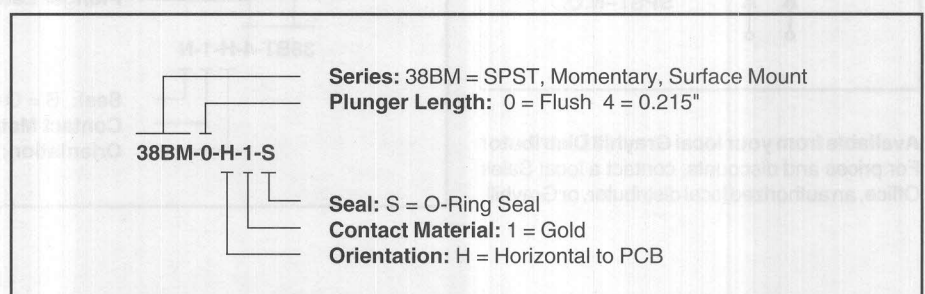
Switch Support: Brass, tin plated

CIRCUITRY



Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

ORDERING INFORMATION

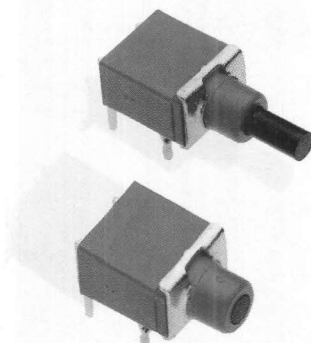


MINIATURE HORIZONTAL PC MOUNT PUSHBUTTON SWITCH

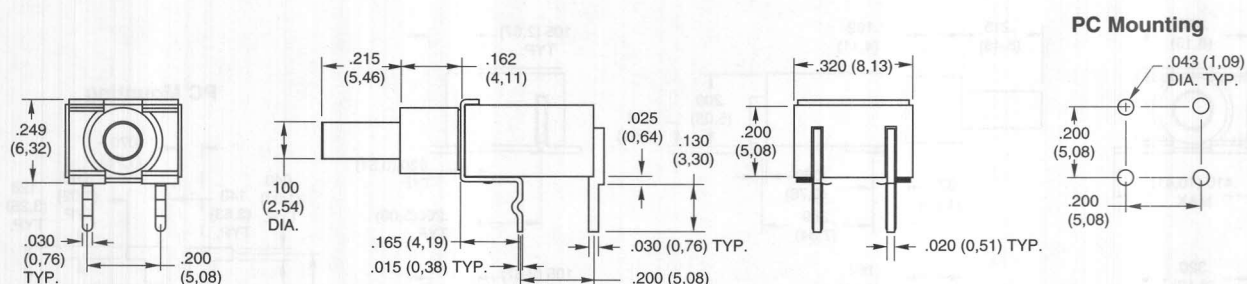
SERIES 38

FEATURES

- Drop-In Replacement for Industry Standard
- Sealed Plunger Option
- Printed Circuit Board Mount
- SPST, Momentary Contact



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Electrical Ratings

Operating Life: 80,000 make-and-break cycles @ full load

Contact Rating (resistive load):

Gold Contacts: 0.4 VA max. @ 20 Vac or Vdc max.

Silver Contacts: 1.0 Amp max. @ 120 Vac or 28 Vdc

Contact Resistance: Below 20 milliohms typ. initial @ 2-4 Vdc, 100 mA

Insulation Resistance: 1000 megaohms min.

Voltage Breakdown: 1000 V RMS minimum @ sea level

Operating Temperature: -30°C. To +85°C.

Solderability: Per MIL STD-202F, Method 208D, or EIA RS-186E Method 9 (1 hour steam aging)

Materials and Finishes

Base and Cover: Thermoplastic (UL 94V-0)

Plunger: Thermoplastic (UL 94V-0), (S versions include an internal O-ring seal)

Terminals: Copper alloy, solder plate over nickel plate

Spring: Plated Music Wire

Contact System: Copper alloy, gold or silver plate (as specified) over nickel plate

Switch Support: Brass, tin plated

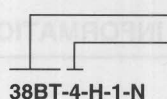
CIRCUITRY



SPST-N.O.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

ORDERING INFORMATION



Series: 38BT = SPST, Momentary, Through Hole
Plunger Length: 0 = Flush 4 = 0.215"

Seal: S = O-Ring Seal N = No Seal

Contact Material: 1 = Gold 2 = Silver

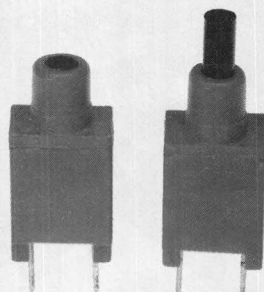
Orientation: H = Horizontal to PCB

MINIATURE VERTICAL PC MOUNT PUSHBUTTON SWITCH

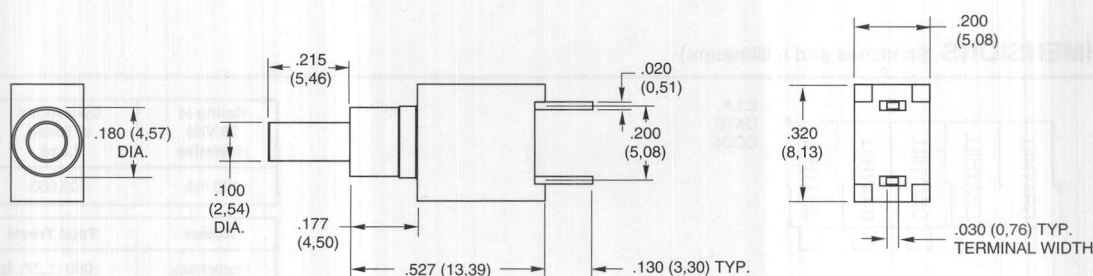
SERIES 38

FEATURES

- Actuates at Right Angle to Printed Circuit Board
- Drop-In Replacement for Industry Standard
- SPST, Momentary Contact
- Sealed Plunger Option



DIMENSIONS In inches (and millimeters)



Unless otherwise indicated, tolerances are $\pm .010$ (0,25)

SPECIFICATIONS

Electrical Ratings

Operating Life: 80,000 make-and-break cycles @ full load

Contact Rating (resistive load):

Gold Contacts: 0.4 VA max. @ 20 Vac or Vdc max.

Silver Contacts: 1.0 Amp max. @ 120 Vac or 28 Vdc

Contact Resistance: Below 20 milliohms typ. initial @ 2-4 Vdc, 100 mA, for both silver and gold plated contacts

Insulation Resistance: 1000 megaohms min.

Voltage Breakdown: 1000 V RMS minimum @ sea level

Operating Temperature: -30°C. To +85°C.

Solderability: Per MILSTD-202F, Method 208D, or EIA RS-186E Method 9 (1 hour steam aging)

Materials and Finishes

Base and Cover: Thermoplastic (UL 94V-0)

Plunger: Thermoplastic (UL 94V-0), (S versions include an internal O-ring seal)

Terminals: Copper alloy, solder plate over nickel plate

Spring: Plated Music Wire

Contact System: Copper alloy, gold or silver plate (as specified) over nickel plate

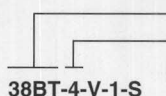
CIRCUITRY



SPST-N.O.

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

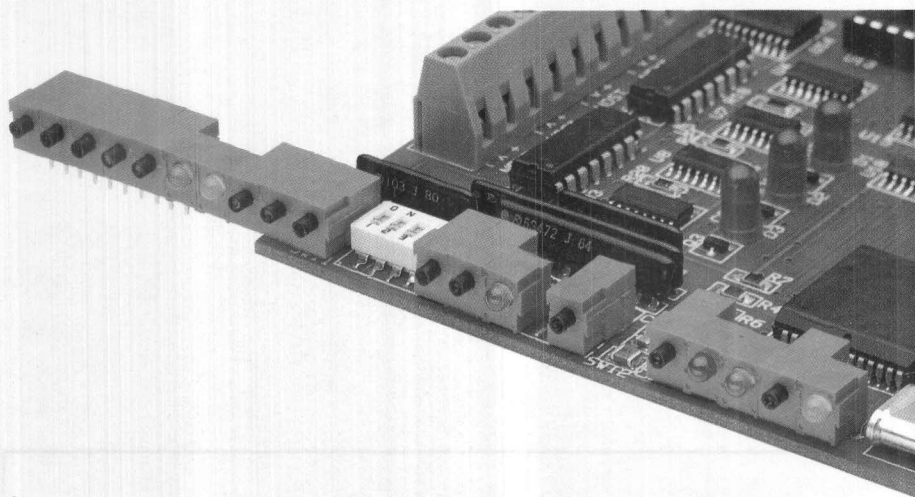
ORDERING INFORMATION



Series: 38BT = SPST, Momentary, Through Hole
Plunger Length: 0 = Flush 4 = 0.215"

Seal: S = O-Ring Seal N = No Seal
Contact Material: 1 = Gold 2 = Silver
Orientation: V = Vertical to PCB

MINIATURE PC MOUNT PUSHBUTTON SWITCHES

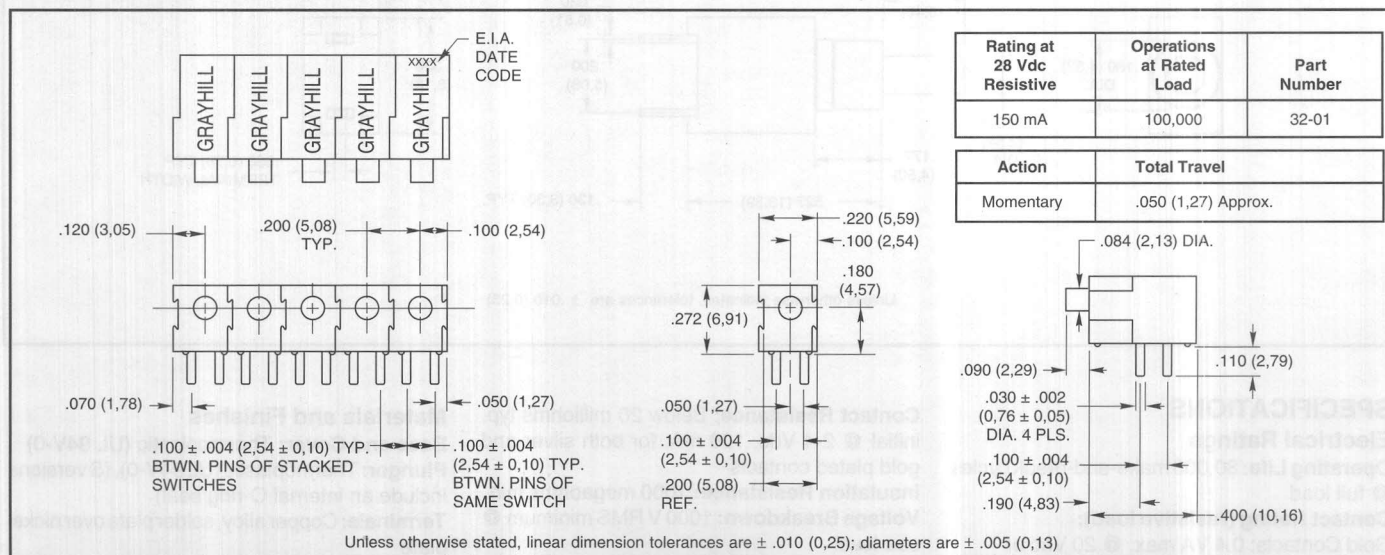


SERIES 32

FEATURES

- **Stackable**, Provides Custom Switch Arrangements
- **.200" Centers** When Stacked
- **SPST-N.O.**, **SPST-N.C.** Circuitry in the Same Package
- **Process Compatible**, Internally Sealed Plunger
- **Status/Reset or Press-to-Test** Functions with Companion LED

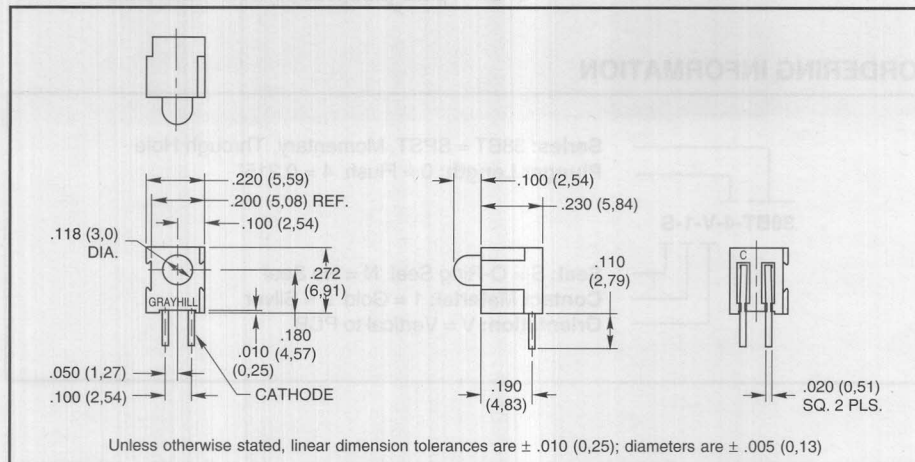
SWITCH DIMENSIONS (In inches and millimeters)



Rating at 28 Vdc Resistive	Operations at Rated Load	Part Number
150 mA	100,000	32-01

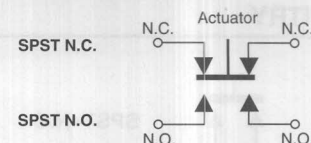
Action	Total Travel
Momentary	.050 (1,27) Approx.

LED DIMENSIONS (In inches and millimeters)

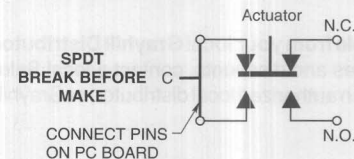


SWITCH CIRCUITRY

2 Circuits Per Switch



Alternate Wiring



See following page for further dimensions, circuitry, specifications, accessories and ordering information.

MINIATURE PC MOUNT PUSHBUTTON SWITCHES

SPECIFICATIONS

Rating Criteria

Contact Resistance: 25 milliohms maximum on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Switch and LED Operating Temperature: -40°C to +85°C

Materials and Finishes

Switch Base, LED Base, Button and Cover: Polyester

Shorting Bar: Phosphor bronze, gold plated over nickel

Switch Terminals: Brass, gold plated over nickel

LED Terminals: Steel, tin plated

Spring: Tinned Music Wire

LED Information

Color	MCD*		Viewing Angle
	Min.	Max.	
Red	0.8	5.0	60°
Green	0.8	3.2	60°
Yellow	0.8	3.2	60°

*MCD = Millicandelas at 2 mA

Recommended Current: 2mA

Current limiting resistor is **not** supplied.

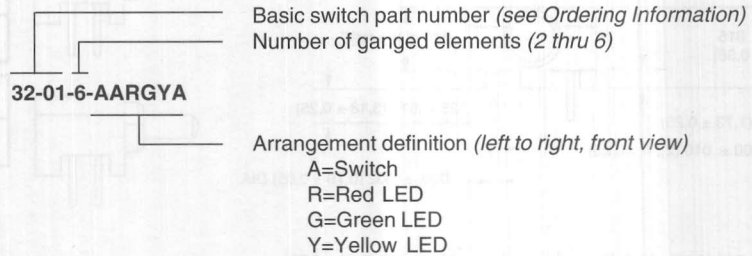
ORDERING INFORMATION—Individual Units

Part Number	Description
32-01	Switch, 10 microinches gold plating, black button, red body
32-02	Switch, 30 microinches gold plating, black button, red body
32LED-RED	Red LED and holder, red body
32LED-GRN	Green LED and holder, red body
32LED-YEL	Yellow LED and holder, red body

Grayhill or your local distributor will assemble stacks of switches, LEDs or combinations.

Assemblies of Switches or Switches and LED Combinations

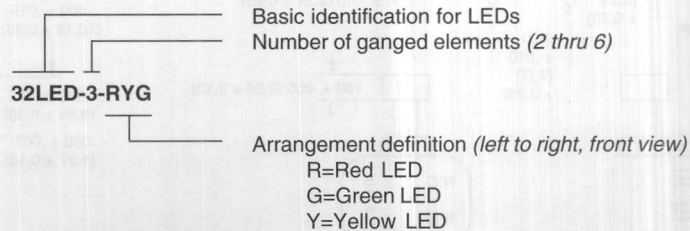
Example Part Number



Example part number describes a stack of 6 elements consisting of two switches, a red LED, a green LED, a switch and a yellow LED. Shorter stacks will have fewer letters in the arrangement definition. Contact Grayhill for stacks of more than six elements.

Assemblies of LEDs Only

Example Part Number



Example part number describes a stack of 3 LEDs, arranged red, yellow and green from left to right. Maximum number of stacked LEDs in this part numbering scheme is six. Contact Grayhill for stacks of more than six elements.

Available from your local Grayhill Distributor.

For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

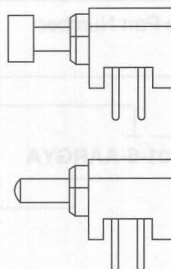
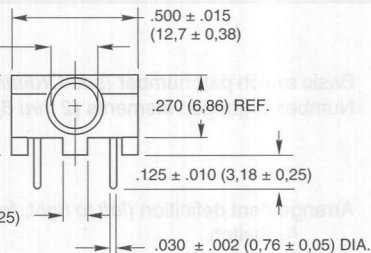
39-261*

.187 ± .010 (4,75 ± 0,25) DIA.

.328 ± .015
(8,33 ± 0,38)

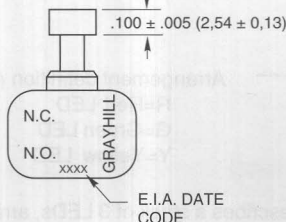
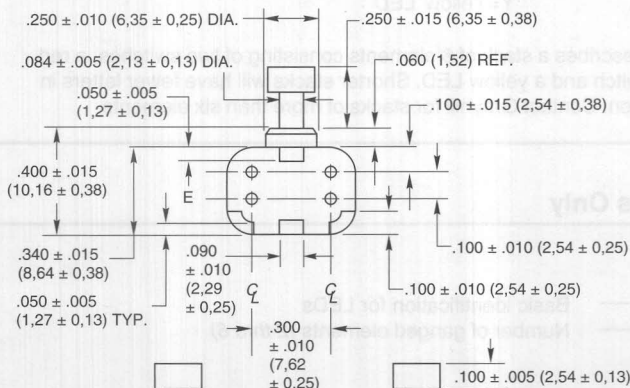
.068 ± .010 (1,73 ± 0,25)

.100 ± .010 (2,54 ± 0,25)



Rating at 28 Vdc Resistive	Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Partial Part Number
150 mA	1/4 Amp	1/8 Amp	500,000	39-251* 39-261*

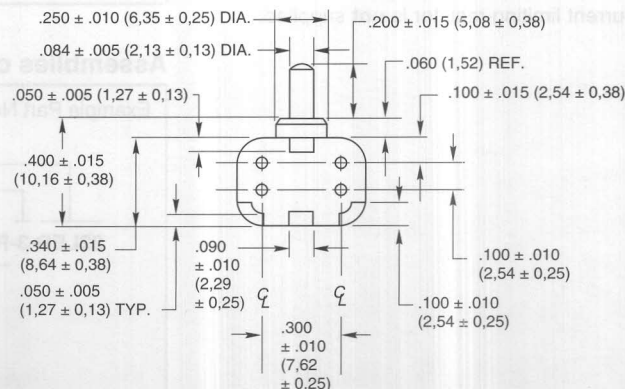
Action	Total Travel	Actuating Force (oz.)
Momentary	.090 ± .010 / - .015 (2,29 ± 0,25 / - 0,38)	10 ± 3 oz.



Small Button Style

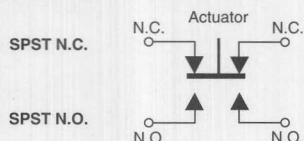
39-251*

END OF BUTTON HAS A .200 (5,08) SPHERICAL RADIUS

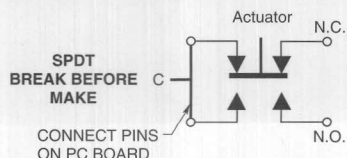


CIRCUITRY

2 Circuits Per Switch



Alternate Wiring



SPECIFICATIONS

Rating Criteria

Contact Resistance: 25 milliohms maximum on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Operating Temperature: -40°C to +125°C

Materials and Finishes

Button: Nylon

Base and Cover: Polyester, red in color

Shorting Bar: Phosphor bronze, gold plated over nickel

Terminals: Brass, gold plated over nickel

Spring: Tinned music wire

O-Ring: Fluorosilicone

ORDERING INFORMATION

*Complete Part Number	Description
39-251 RED	Small Red Button, SPDT
39-251 BLK	Small Black Button, SPDT
39-261 RED	Large Red Button, SPDT
39-261 BLK	Large Black Button, SPDT

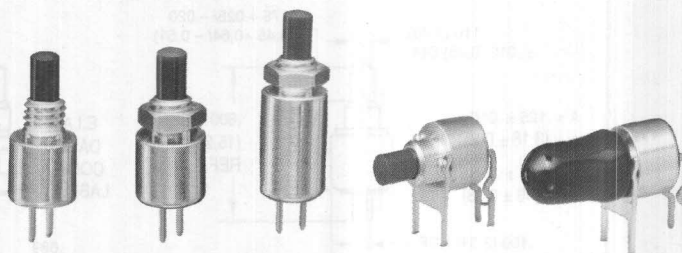
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MINIATURE PC MOUNT PUSHBUTTON SWITCHES

SERIES 39

FEATURES

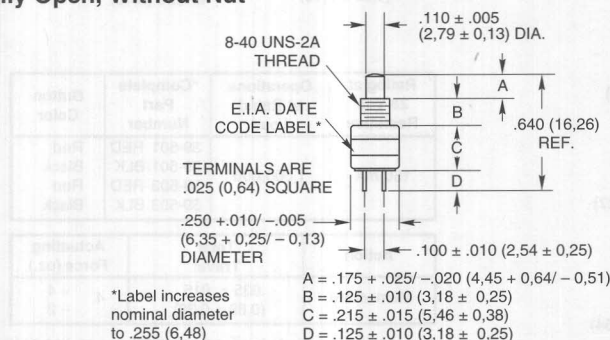
- 1/4" in Diameter
- Up to 1,000,000 Cycles of Operation



DIMENSIONS In Inches (and millimeters)

SPST—Normally Open, Without Nut

39-405*

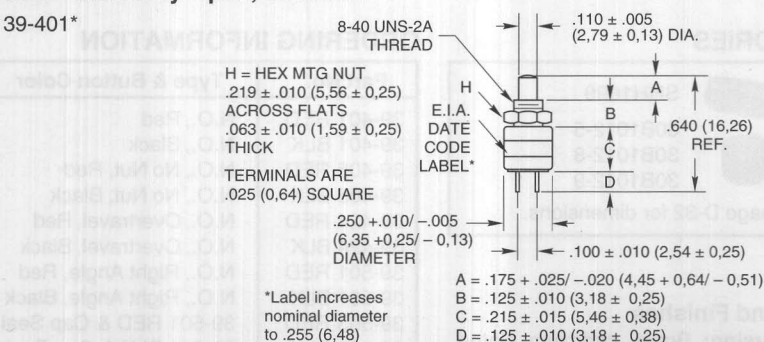


Rating at 28 Vdc Resistive	Operations at Rated Load	*Complete Part Number	Button Color
150 mA	1,000,000	39-405 RED 39-405 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)
Momentary	.035 ± .015 (0,89 ± 0,38)	4 + 4 - 2

SPST—Normally Open, With Nut

39-401*

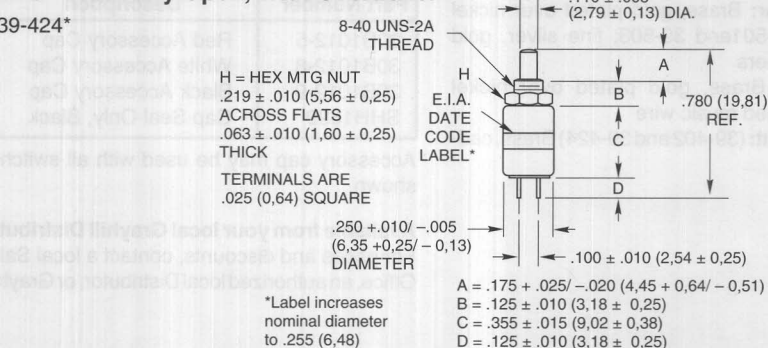


Rating at 28 Vdc Resistive	Operations at Rated Load	*Complete Part Number	Button Color
150 mA	1,000,000	39-401 RED 39-401 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)
Momentary	.035 ± .015 (0,89 ± 0,38)	4 + 4 - 2

SPST—Normally Open, With Overtravel

39-424*



Rating at 28 Vdc Resistive	Operations at Rated Load	*Complete Part Number	Button Color
150 mA	100,000	39-424 RED 39-424 BLK	Red Black

Action	Total Travel	Over Travel	Actuating Force (oz.)
Momentary	.130 ± .025 (3,30 ± 0,64)	.015 (0,38) Min.	5 ± 3

See page D-13 for circuitry, specifications and ordering information.

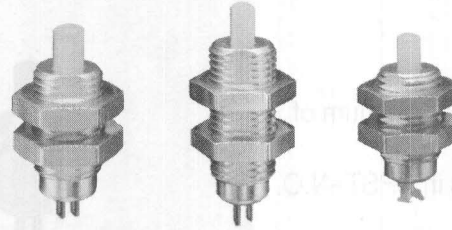
MINIATURE LIMIT PUSHBUTTON SWITCHES

SERIES 39

FEATURES

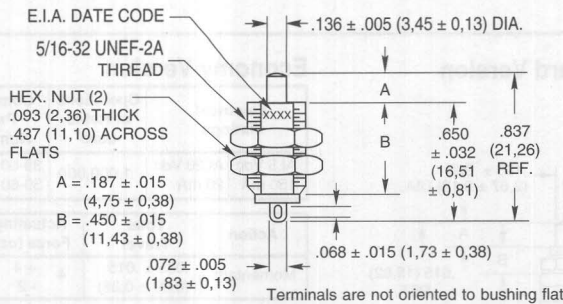
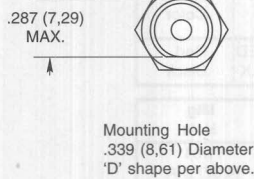
- Adjustable Location Setting
- Plunger Sealed Version

DIMENSIONS In Inches (and millimeters)



SPST-Normally Open, With Overtravel

39-101



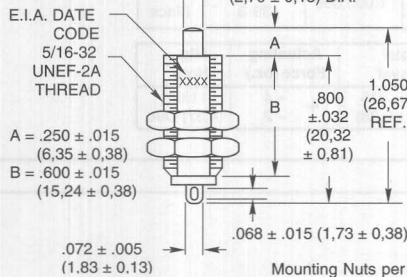
Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
1/2 Amp	1/4 Amp	500,000	39-101	Nat. Nylon

Action	Total Travel	Over Travel	Actuating Force (oz.)
Momentary	.187 ± .015 (4,75 ± 0,38)	.060 (2,03) Min. from top of bushing	5 + 3 - 2

SPST-Normally Open, With Extended Overtravel

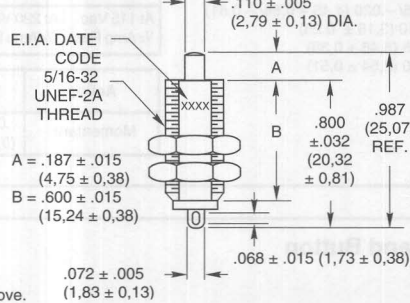
39-102

39-103



SPST-Normally Open, With Overtravel, Sealed Actuator

39-701

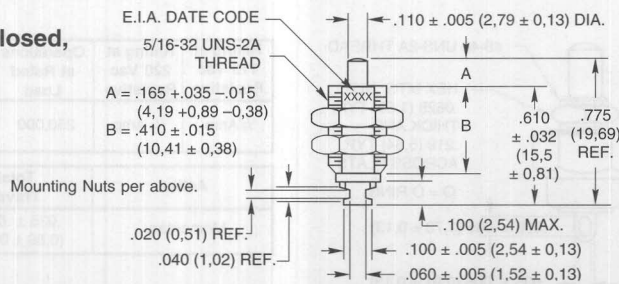


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
150 mA	75 mA	30,000	39-102	Nat. Nylon
150 mA	75 mA	100,000	39-701	Nat. Nylon
1/2 Amp	1/4 Amp	30,000	39-103	Nat. Nylon

Action	Total Travel	Over Travel	Actuating Force (oz.)
Momentary	.250 ± .015 (6,35 ± 0,38)	39-102 and 39-103: .200 (5,08) Nominal. from top of bushing	6.8 ± 5
Momentary	.187 ± .015 (4,75 ± 0,38)	39-701: .060 (2,03) Min. from top of bushing	8 ± 4

SPST-Normally Closed, Sealed Actuator

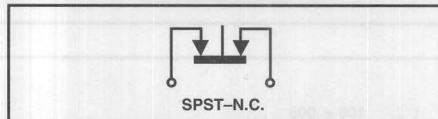
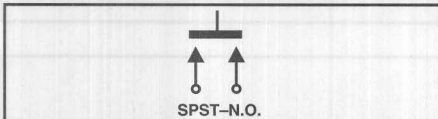
39-702



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
1/4 Amp	1/8 Amp	100,000	39-702	Nat. Nylon

Action	Total Travel	Over Travel	Actuating Force (oz.)
Momentary	.042 ± .010 (1,07 ± 0,25)	None	8 ± 4

CIRCUITRY



SPECIFICATIONS

Rating Criteria

Contact Resistance: 25 milliohms maximum on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Operating Temperature: -40°C to +85°C

Materials and Finishes

Bushing and Mounting Nuts: Brass, cadmium plated

Insulation Sleeve: Molded polyester for 39-101, 39-102, 39-103 and 39-701; phenolic per MIL-M-14 type CFG for 39-702

Base: Thermoset plastic

Terminals: Commercial bronze for 39-101, 39-102, 39-103 and 39-701; Silver for 39-702

Springs: Tinned music wire

Contacts: Fine silver, gold plated for 39-101, 39-102, 39-103 and 39-701; fine silver for 39-702

Button: Thermoplastic

O-Ring: (39-701 & 39-702) Silicone

STANDARD OPTIONS

Epoxy sealed terminals and wire leads, see page D-33.

Optional plating: gold plated contacts for dry circuit conditions, contact Grayhill.

ORDERING INFORMATION

Part No.	Description
39-101	SPST, N.O. With Overtravel
39-102	SPST, N.O. With Extended Overtravel
39-103	SPST, N.O. With Extended Overtravel
39-701	SPST, N.O. With Overtravel, Sealed
39-702	SPST, N.C. Sealed

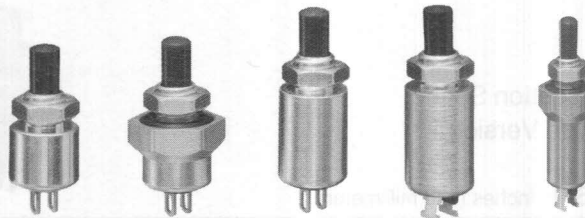
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

150 mA TO 1/2 AMP BUTT CONTACT PUSHBUTTON SWITCHES

SERIES 39

FEATURES

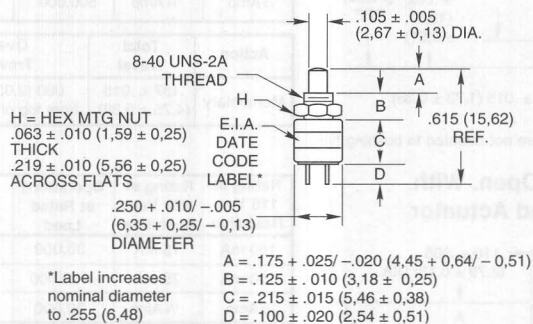
- Requires an Absolute Minimum of Space
- Molded-In Terminals in SPST-N.O.



DIMENSIONS In Inches (and millimeters)

Normally Open-SPST Economy and Standard Version

39-1
39-3
39-601*



Economy Version

Electrical Ratings	Operations at Rated Load	*Complete Part Number	Button Color
At 5 Vdc 150 mA	At 20 Vdc 20 mA	1,000,000	39-601 RED 39-601 BLK

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.035 ± .015 (0,89 ± 0,38)	4 + 4 - 2	11/64" (4,37) DIA.

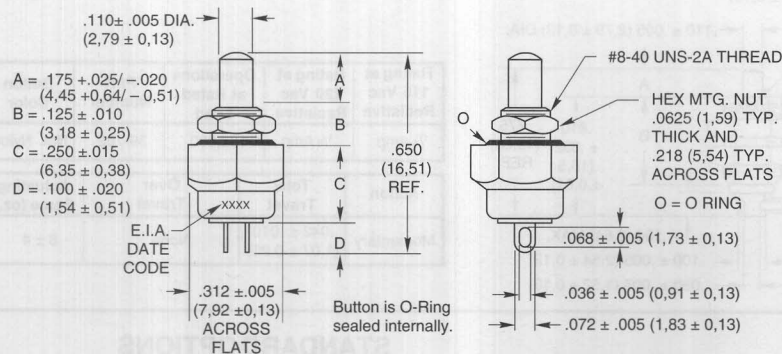
Standard

Electrical Ratings	Operations at Rated Load	Complete Part Number	Button Color
At 115 Vac 1/2 Amp Res.	At 220 Vac 1/4 Amp Res.	1,000,000	39-1 39-3

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.035 ± .015 (0,89 ± 0,38)	4 + 4 - 2	11/64" (4,37) DIA.

Normally Open-SPST with Sealed Bushing and Button

39-351*

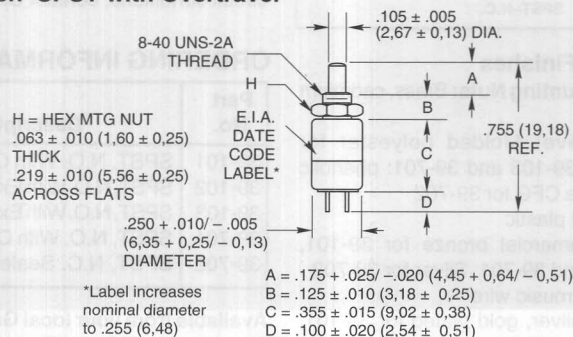


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1/2 Amp	1/4 Amp	250,000	39-351 RED 39-351 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)
Momentary	.035 ± .015 (0,89 ± 0,38)	16 ± 8

Normally Open-SPST with Overtravel

39-12
39-24



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Complete Part Number	Button Color
1/2 Amp	1/4 Amp	100,000	39-12 39-24	Red Black

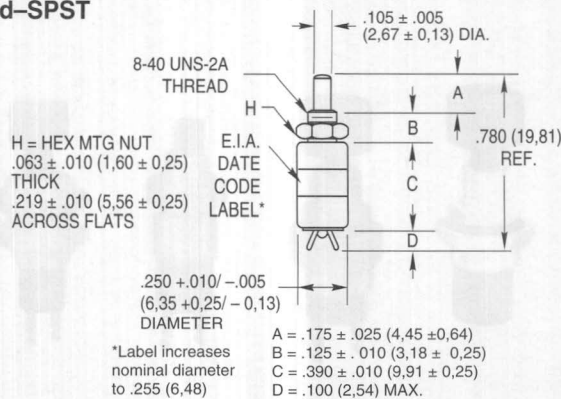
Action	Total Travel	Over Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.130 ± .025 (3,30 ± 0,64)	.015 (0,38) Min.	5 ± 3	11/64" (4,37) DIA.

150 mA TO 1/2 AMP BUTT CONTACT PUSHBUTTON SWITCHES

DIMENSIONS In Inches (and millimeters)

Normally Closed-SPST

39-2

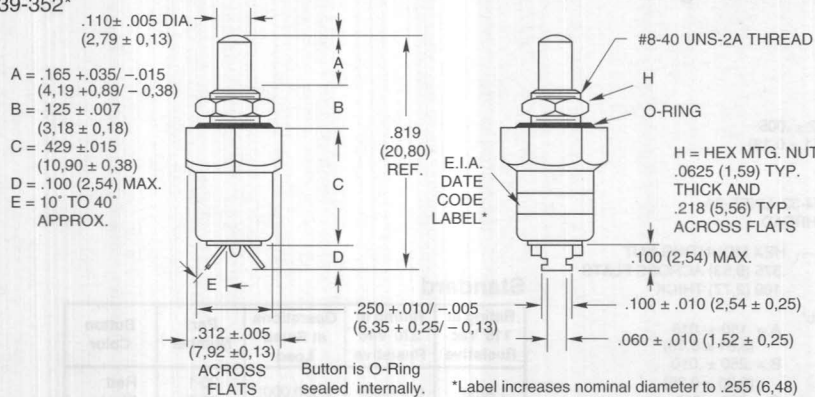


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Cap Color
1/4 Amp	1/8 Amp	250,000	39-2	Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.042 ± .010 (1.07 ± 0.25)	4 + 4 - 2	.172 (4.37) DIA.

Normally Closed-SPST with Sealed Bushing and Button

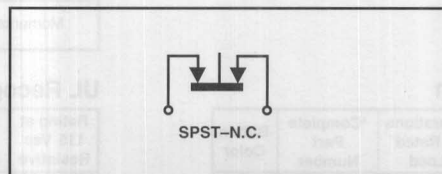
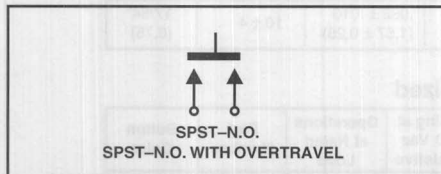
39-352*



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1/4 Amp	1/8 Amp	100,000	39-352 RED 39-352 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)
Momentary	.042 ± .010 (0.17 ± 0.25)	8 ± 4

CIRCUITRY



SPECIFICATIONS

Rating Criteria

Contact Resistance: 25 milliohms maximum on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Operating Temperature: -40°C to +85°C

Mounting Torque: 2 in-lb

Materials and Finishes

Mounting Nut: Brass, cadmium plated

Housing: Aluminum, cadmium plated for 39-351 and 39-352; Brass, cadmium plated for others

Button: Thermoset plastic

Base: Thermoset plastic

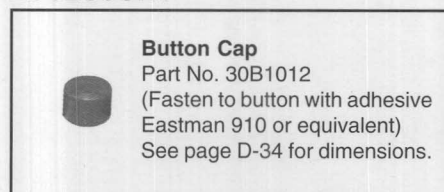
Shorting Bar: Fine silver for 39-2 and 39-352; brass, gold plated over nickel plate for 39-601; fine silver, gold plated for others

Terminals: Fine silver for 39-2 and 39-351; commercial bronze with gold plated fine silver contact surface for others

Spring: Tinned music wire

O-Rings: (39-351 and 39-352) Internal ring is silicone; external ring is buna 'N'

ACCESSORY



STANDARD OPTIONS

Epoxy sealed and wire leads, see page D-31.

ORDERING INFORMATION

Part Number	Description
39-1	N.O., Red Button
39-2	N.C., Black Button
39-3	N.O., Black Button
39-12	N.O., Overtravel Red Button
39-24	N.O., Overtravel Black Button
39-351 RED	N.O., Sealed, Red Button
39-351 BLK	N.O., Sealed, Black Button
39-352 RED	N.C., Sealed, Red Button
39-352 BLK	N.C., Sealed, Black Button
39-601 RED	N.O., Economy, Red Button
39-601 BLK	N.O., Economy, Black Button

Accessory cap may be used with all switches shown except 39-2.

Accessory Part Number	Description
30B1012-5	Red Button Cap
30B1012-9	Black Button Cap
30B1012-8	White Button Cap

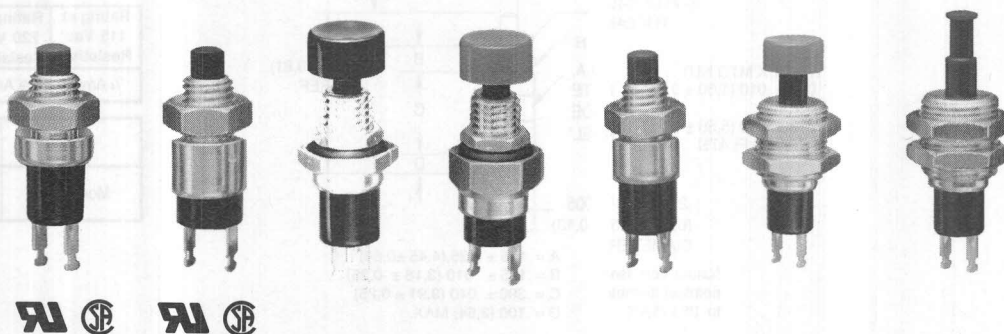
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1 AND 5 AMP BUTT CONTACT PUSHBUTTON SWITCHES

SERIES 30

FEATURES

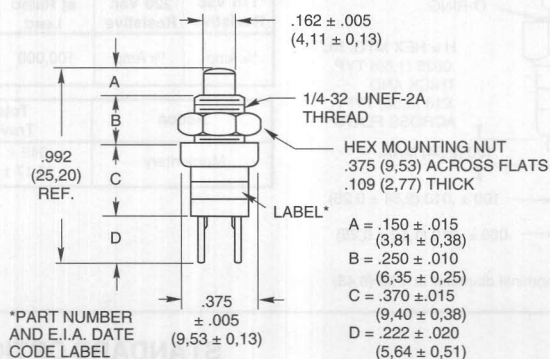
- Reliable
- Economical
- Large Selection
- UL Recognized
- CSA Certified



DIMENSIONS In Inches (and millimeters)

Normally Open-SPST Standard, Economy and UL Recognized

30-1
30-1UL
30-3
30-3UL
30-601*



Standard

Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
1 Amp	0.5 Amp	1,000,000	30-1 30-3	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.062 ± .010 (1,57 ± 0,25)	10 ± 4	17/64" (6,75)

Economy Version

Electrical Ratings		Operations at Rated Load	*Complete Part Number	Button Color
At 5 Vdc 150 mA	At 20 Vdc 20 mA	1,000,000	30-601 RED 30-601 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.062 ± .010 (1,57 ± 0,25)	10 ± 4	17/64" (6,75)

UL Recognized

Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
5 Amp	2.5 Amp	6,000	30-1UL 30-3UL	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.062 ± .010 (1,57 ± 0,25)	10 ± 4	17/64" (6,75)

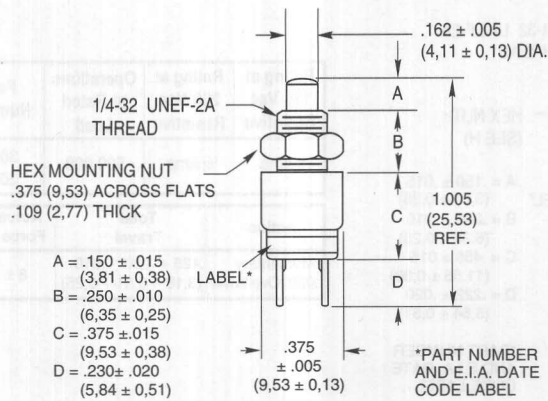
See page D-20 for circuitry, specifications and ordering information.

1 AND 5 AMP BUTT CONTACT PUSHBUTTON SWITCHES

DIMENSIONS In Inches (and millimeters)

Normally Closed-SPST and UL Recognized

30-2
30-2UL
30-6
30-6UL



Normally Closed-SPST

Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
1 Amp	1/2 Amp	1,000,000	30-2 30-6	Black Red

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.065 + .010 / - .015 (1.65 + 0.25 / - 0.38)	8 ± 4	17/64" (6.75)

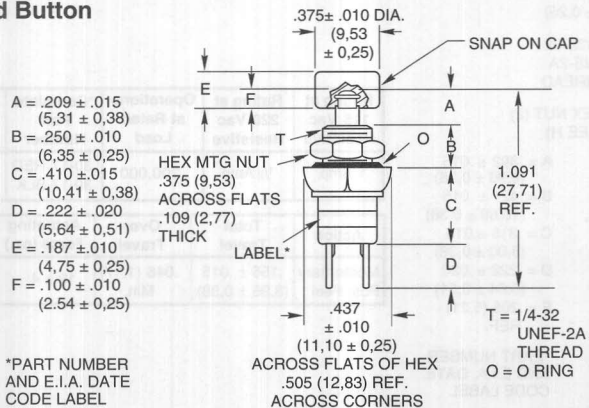
UL Recognized

Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
5 Amp	—	6,000	30-2UL 30-6UL	Black Red

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.065 + .010 / - .015 (1.65 + 0.25 / - 0.38)	8 ± 4	17/64" (6.75)

Normally Open-SPST With Sealed Bushing and Button

30-251*

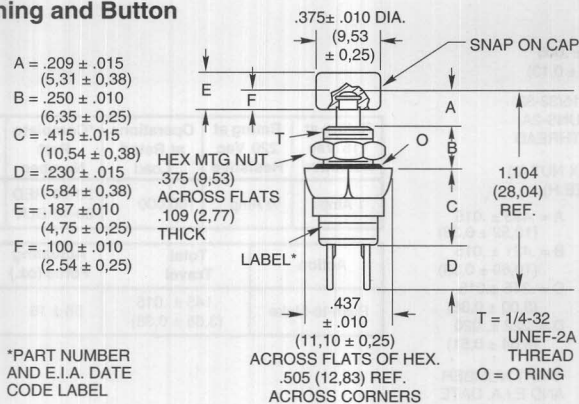


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1 Amp	1/2 Amp	250,000	30-251 RED 30-251 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.062 ± .020 (1.57 ± 0.51)	30 ± 8	17/64" (6.75)

Normally Closed-SPST With Sealed Bushing and Button

30-252*



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1 Amp	1/2 Amp	250,000	30-252 RED 30-252 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary	.065 ± .010 (1.65 ± 0.25)	12 ± 4	17/64" (6.75)

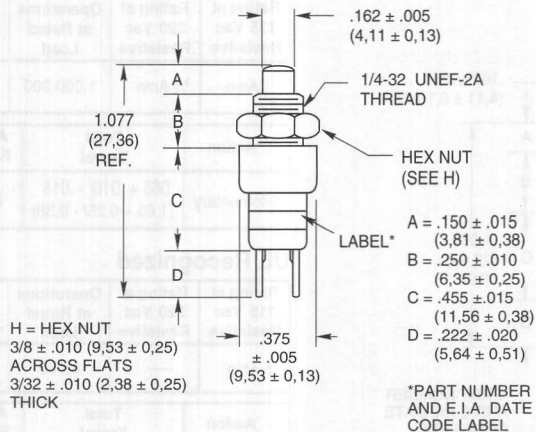
See page D-20 for circuitry, specifications and ordering information.

1 AND 5 AMP BUTT CONTACT PUSHBUTTON SWITCHES

DIMENSIONS In Inches (and millimeters)

Normally Open-SPST With Overtravel

30-15
30-37

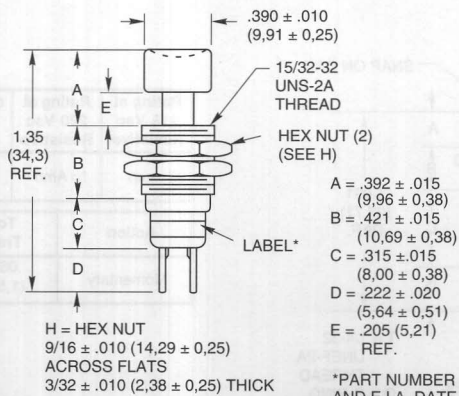


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	Part Number	Button Color
1 Amp	1/2 Amp	500,000	30-15 30-37	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Momentary .020" Overtravel	.125 ± .020 / - .010 (3,18 ± 0,51 / - 0,25)	8 ± 4	17/64" (6,75)

Normally Open-SPST With Positive Feel

30-17*

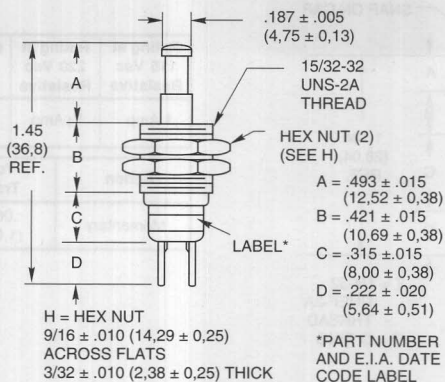


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1 Amp	1/2 Amp	200,000	30-17 RED 30-17 BLK	Red Black

Action	Total Travel	Over Travel	Actuating Force (oz.)	Mtg. Hole
Momentary Pos. Feel	.156 ± .015 (3,96 ± 0,38)	.046 (1,17) Min.	18 ± 4	31/64" (12,30)

Normally Open-SPST With Push-Pull

30-16*



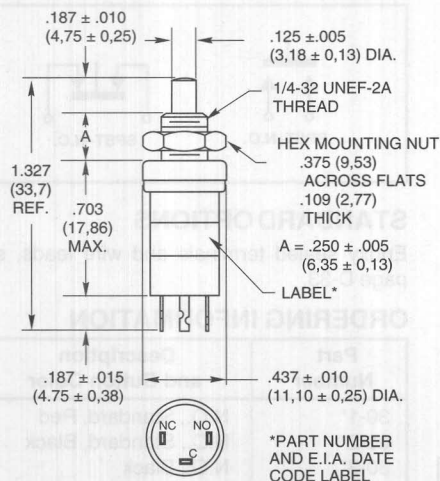
Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button Color
1 Amp	1/2 Amp	100,000	30-16 RED 30-16 BLK	Red Black

Action	Total Travel	Actuating Force (oz.)	Mtg. Hole
Push-to-Make	.145 ± .015 (3,68 ± 0,38)	56 ± 16	31/64" (12,30)

DIMENSIONS In Inches (and millimeters)

Single Pole/Double Throw

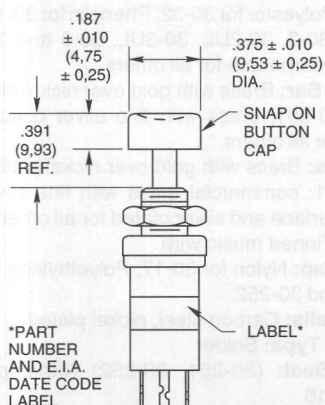
46-101* (BBM)
46-110* (MBB)



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Button or Cap Color
1/4 Amp	1/8 Amp	250,000	46-101 RED	Red
			46-101 BLK	Black
			46-102 RED	Red
			46-102 BLK	Black
			46-110 RED	Red
			46-110 BLK	Black
			46-111 RED	Red
			46-111 BLK	Black

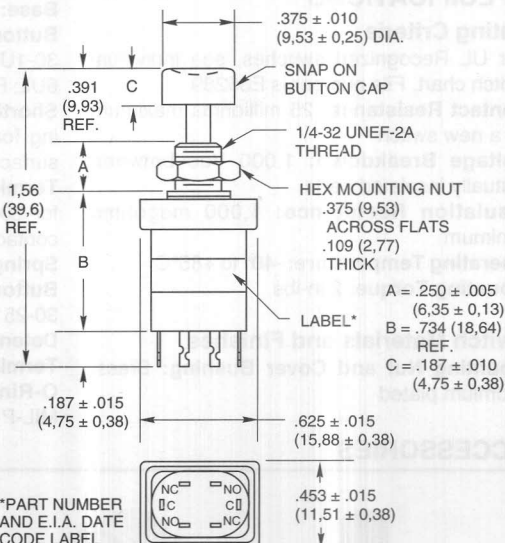
Action	Total Travel	Bottoming Force (oz.)	Mtg. Hole
Momentary	.180 (4,57) Min.	17 ± 5	17/64" (6,75)

46-102* (BBM)
46-111* (MBB)



Double Pole/Double Throw

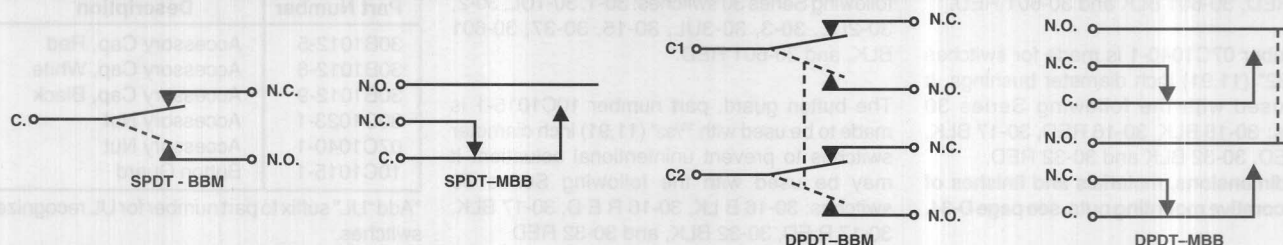
46-200* (BBM)
46-201* (MBB)



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Cap Color
1/4 Amp	1/8 Amp	250,000	46-200 RED	Red
			46-200 BLK	Black
			46-201 RED	Red
			46-201 BLK	Black

Action	Total Travel	Bottoming Force (oz.)	Mtg. Hole
Momentary	.180 (4,57) Min.	35 ± 9	17/64" (6,75)

CIRCUITRY



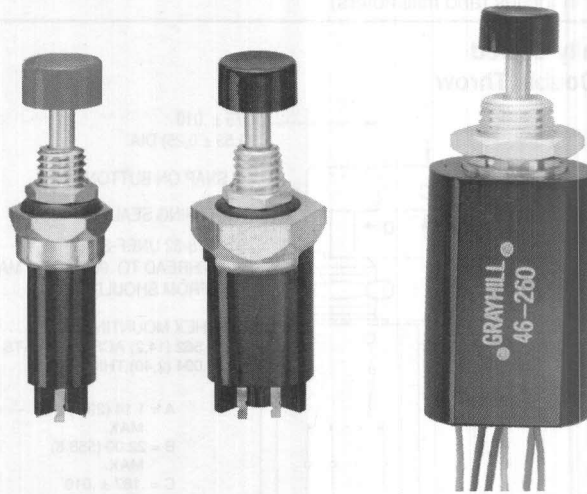
See page D-23 for specifications and ordering information.

1/4 AMP WIPING CONTACT PUSHBUTTON SWITCHES

SERIES 46

FEATURES

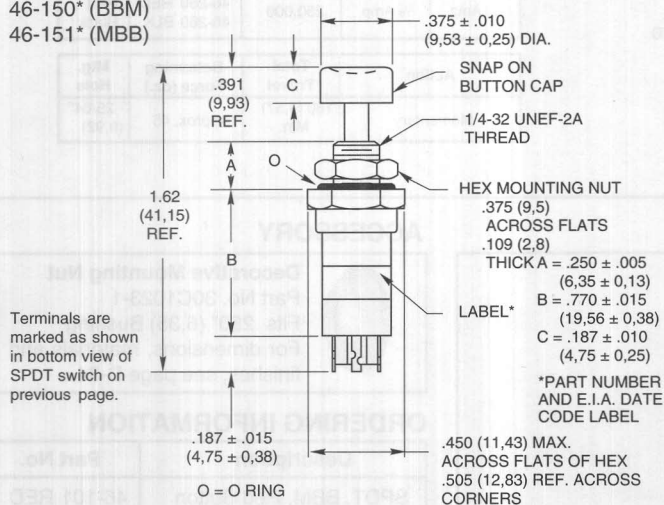
- Bushing and Button Seal
- Environmentally Sealed



DIMENSIONS In Inches (and millimeters)

Sealed Bushing and Button Single Pole/Double Throw

46-150* (BBM)
46-151* (MBB)

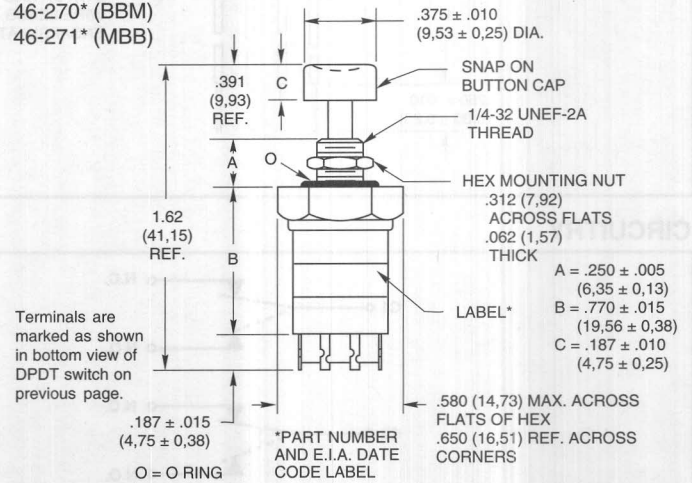


Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Cap Color
1/4 Amp	1/8 Amp	100,000	46-150 RED 46-150 BLK 46-151 RED 46-151 BLK	Red Black Red Black

Action	Total Travel	Bottoming Force (oz.)	Mtg. Hole
Momentary	.180 (4,57) Min.	24 ± 4	17/64" (6,75)

Sealed Bushing and Button Double Pole/Double Throw

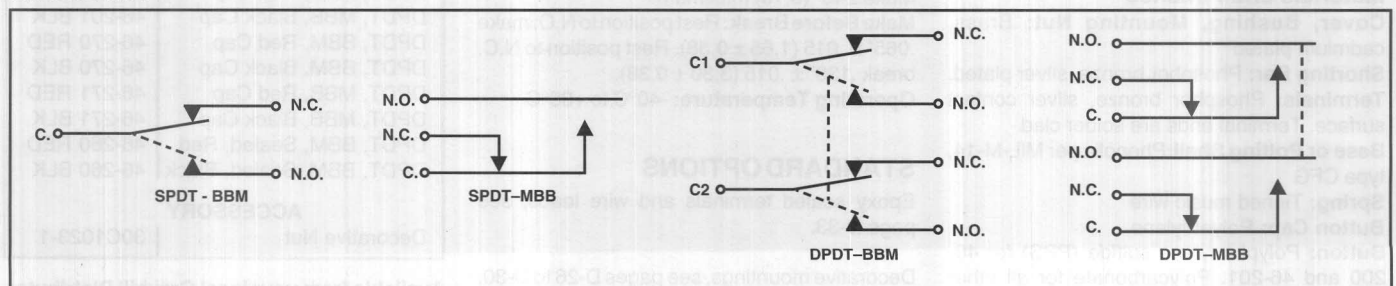
46-270* (BBM)
46-271* (MBB)



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Cap Color
1/4 Amp	1/8 Amp	100,000	46-270 RED 46-270 BLK 46-271 RED 46-271 BLK	Red Black Red Black

Action	Total Travel	Bottoming Force (oz.)	Mtg. Hole
Momentary	.180 (4,57) Min.	48 ± 4	17/64" (6,75)

CIRCUITRY



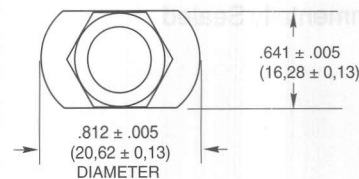
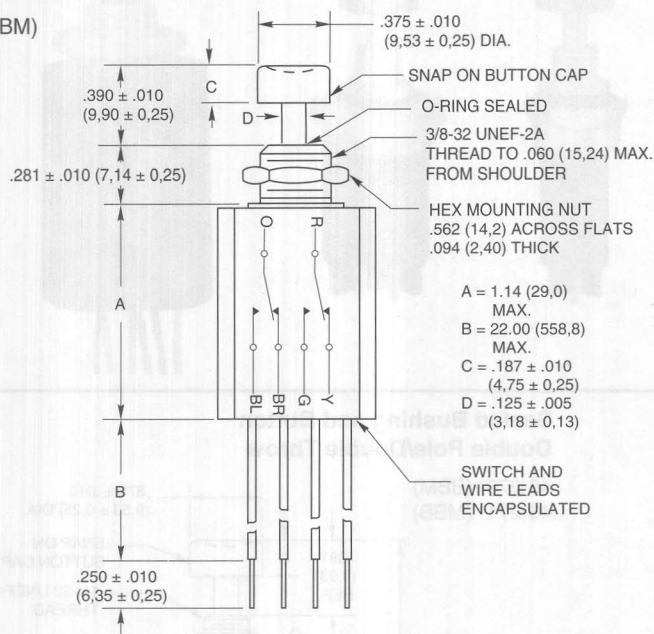
See page D-23 for specifications and ordering information.

1/4 AMP WIPING CONTACT PUSHBUTTON SWITCHES

DIMENSIONS In Inches (and millimeters)

Environmentally Sealed Double Pole/Double Throw

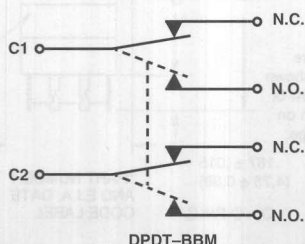
46-260* (BBM)



Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Operations at Rated Load	*Complete Part Number	Cap Color
1/4 Amp	1/8 Amp	250,000	46-260 RED 46-260 BLK	Red Black

Action	Total Travel	Bottoming Force (oz.)	Mtg. Hole
Momentary	.180 (4,57) Min.	Approx. 45	25/64" (9,92)

CIRCUITRY



SPECIFICATIONS

Rating Criteria

Contact Resistance: Less than 25 milliohms at the switch initially. Less than 4 milliohms/inch of wire.

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Materials and Finishes

Cover, Bushing, Mounting Nut: Brass, cadmium plated

Shorting Bar: Phosphor bronze, silver plated.

Terminals: Phosphor bronze, silver contact surface. Terminal ends are solder clad

Base or Potting Shell: Phenolic per MIL-M-14, type CFG

Spring: Tinned music wire

Button Cap: Polyethylene

Button: Polyphenylene sulfide (PPS) for 46-200 and 46-201. Polycarbonate for all other unsealed versions. Aluminum for all sealed versions.

O-Ring Seal: Nitrile per MIL-P-5516, class B

Seal Adapter and Hex Nut (46-260): Brass, cadmium plated

Wire Leads (46-260): Per MIL-W-16878 type E. #26AWG, insulated teflon, copper stranded wire

Operating Features

Break Before Make: Rest position to N.C. break .020" (0,51) minimum. Rest position to N.O. Make .240" (6,10) maximum.

Make Before Break: Rest position to N.O. make .065" ± .015 (1,65 ± 0,38). Rest position to N.C. break .130" ± .015 (3,30 ± 0,38).

Operating Temperature: -40°C to +85°C

STANDARD OPTIONS

Epoxy sealed terminals and wire leads, see page D-33.

Decorative mountings, see pages D-26 to D-30.

ACCESSORY



Decorative Mounting Nut

Part No. 30C1023-1

Fits .250" (6,35) Bushing

For dimensions, materials and finishes, see page D-34.

ORDERING INFORMATION

Description	Part No.
SPDT, BBM, Red Button	46-101 RED
SPDT, BBM, Black Button	46-101 BLK
SPDT, BBM, Red Cap	46-102 RED
SPDT, BBM, Black Cap	46-102 BLK
SPDT, MBB, Red Button	46-110 RED
SPDT, MBB, Black Button	46-110 BLK
SPDT, MBB, Red Cap	46-111 RED
SPDT, MBB, Black Cap	46-111 BLK
SPDT, BBM, Red Cap	46-150 RED
SPDT, BBM, Black Cap	46-150 BLK
SPDT, MBB, Red Cap	46-151 RED
SPDT, MBB, Black Cap	46-151 BLK
DPDT, BBM, Red Cap	46-200 RED
DPDT, BBM, Black Cap	46-200 BLK
DPDT, MBB, Red Cap	46-201 RED
DPDT, MBB, Black Cap	46-201 BLK
DPDT, BBM, Red Cap	46-270 RED
DPDT, BBM, Black Cap	46-270 BLK
DPDT, MBB, Red Cap	46-271 RED
DPDT, MBB, Black Cap	46-271 BLK
DPDT, BBM, Sealed, Red	46-260 RED
DPDT, BBM, Sealed, Black	46-260 BLK

ACCESSORY

Decorative Nut 30C1023-1

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1/4 AMP WIPING CONTACT PUSHBUTTON SWITCHES

SERIES 23

FEATURES

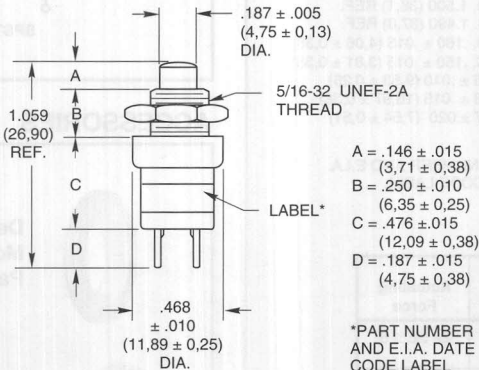
- Momentary Contact
- 100,000 Cycles of Operation



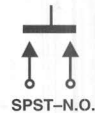
DIMENSIONS In Inches (and millimeters)

Normally Open-SPST

23-1
23-4



CIRCUITRY



ACCESSORY



Decorative Mounting Nut

Part No. 23C1024

For dimensions, materials and finishes, see page D-34.

SPECIFICATIONS

Rating Criteria

Rated: To Make and Break 1/4 Amp at 115 Vac, or 1/8 Amp at 220 Vac resistive.

Contact Resistance: 25 milliohms maximum on a new switch.

Voltage Breakdown: 1,000 Vac between mutually insulated parts.

Insulation Resistance: 1,000 megohms minimum.

Materials and Finishes

Mounting Nut and Cover Bushing: Brass, cadmium plated.

Base: Phenolic per MIL-M-14, Type CFG.

Button: Polycarbonate.

Terminals: Brass, silver plated.

Spring: Tinned music wire

Shorting Bar: Phosphor bronze, silver plated.

Operating Temperature: -40° to +85°C

Operating Features

Total Button Travel: .095 ± .010 (2.41 ± 0.25)

Overtravel: .005 (0.13) minimum

Actuating Force: 16 ounces ± 4

Mounting Hole: 21/64" (8.33)

STANDARD OPTIONS

Epoxy sealed terminals, see page D-33.

ORDERING INFORMATION

Description & Button Color	Part No.
SPST, N.O., Red	23-1
SPST, N.O., Black	23-4
Accessory Nut	23C1024-1

Available From Your Local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1 AND 3 AMP WIPING CONTACT PUSHBUTTON SWITCHES

SERIES 10 SERIES 4000

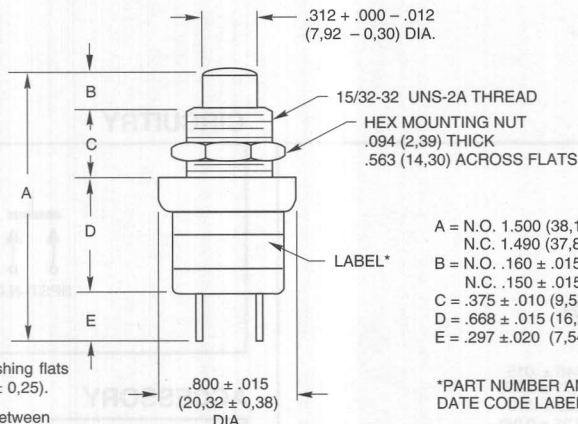
FEATURES

- Momentary or Momentary With Positive Feel
- UL Recognized at 3 Amps



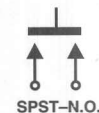
DIMENSIONS In Inches (and millimeters)

4001(UL)
10-09 (UL)
10-100
4002 (UL)
10-10 (UL)
10-101



Action	Part No.	Circuitry	Oper. at Rated Load	Rating at 115 Vac Resistive	Rating at 220 Vac Resistive	Actuating Force
Momentary	4001 10-09	SPST-N.O.	100,000	1 Amp	1/2 Amp	22 oz. ± 8
Momentary	4002 10-10	SPST-N.C.	100,000	1 Amp	1/2 Amp	23 oz. ± 7
Pos. Feel	10-100	SPST-N.O.	100,000	1 Amp	1/2 Amp	35 oz. ± 8
Pos. Feel	10-101	SPST-N.C.	100,000	1 Amp	1/2 Amp	35 oz. ± 10
Underwriters Laboratory Recognized						
Momentary	4001 UL 10-09 UL	SPST-N.O.	6,000	3 Amp	—	22 oz. ± 8
Momentary	4002 UL 10-10 UL	SPST-N.C.	6,000	3 Amp	—	23 oz. ± 7

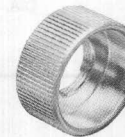
CIRCUITRY



ACCESSORIES



Decorative Mounting Nut
Part No. 07C1040-1



Button Guard
Part No. 10C1015-1

For dimensions, materials and additional accessories, see page D-34.

SPECIFICATIONS

Rating Criteria

Rated: See chart above

Contact Resistance: 25 milliohms or less on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Additional Characteristics

Total Travel: Normally open .110 + .010 / - .020 (2,79 + 0,25 / - 0,51). Normally closed .140 ± .032 (3,56 ± 0,81).

Overtravel: Normally open .020 (0,51) Min.

Pretravel: Normally closed .010 (0,25) Min.

Operating Temperature: -40°C to +85°C

UL Recognition: See chart above for rating. UL file number is 35289.

Materials and Finishes

Mounting Nut: Brass, cadmium plated

Mounting Bushing and Cover: Zinc, cadmium plated

Button and Base: Thermoset plastic

Shorting Bar: Brass, silver plated

Spring: Tinned music wire

Contact Terminals: Beryllium copper, silver plated .0003" to .0005"

STANDARD OPTIONS

Epoxy sealed terminals: not available through distributors

Terminals bent at 90°: contact Grayhill

ORDERING INFORMATION

Description & Button Color	Part No.
SPST, N.O., Red	4001
SPST, N.O., Black	10-09
SPST, N.O., UL, Red	4001UL
SPST, N.O., UL, Black	10-09 UL
SPST, N.O., Positive Feel, Red	10-100
SPST, N.C., Positive Feel, Black	10-101
SPST, N.C., Red	10-10
SPST, N.C., Black	4002
SPST, N.C., UL, Red	10-10 UL
SPST, N.C., UL Black	4002 UL
Accessory Nut	07C1040-1
Accessory Button Guard	10C1015-1

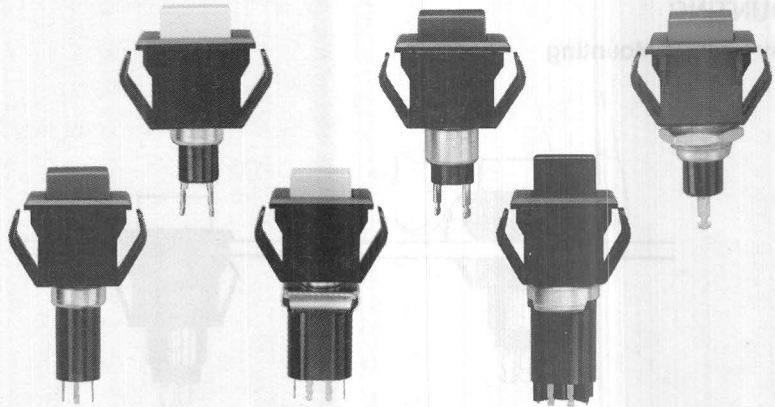
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SNAP-IN PANEL MOUNT PUSHBUTTON SWITCHES

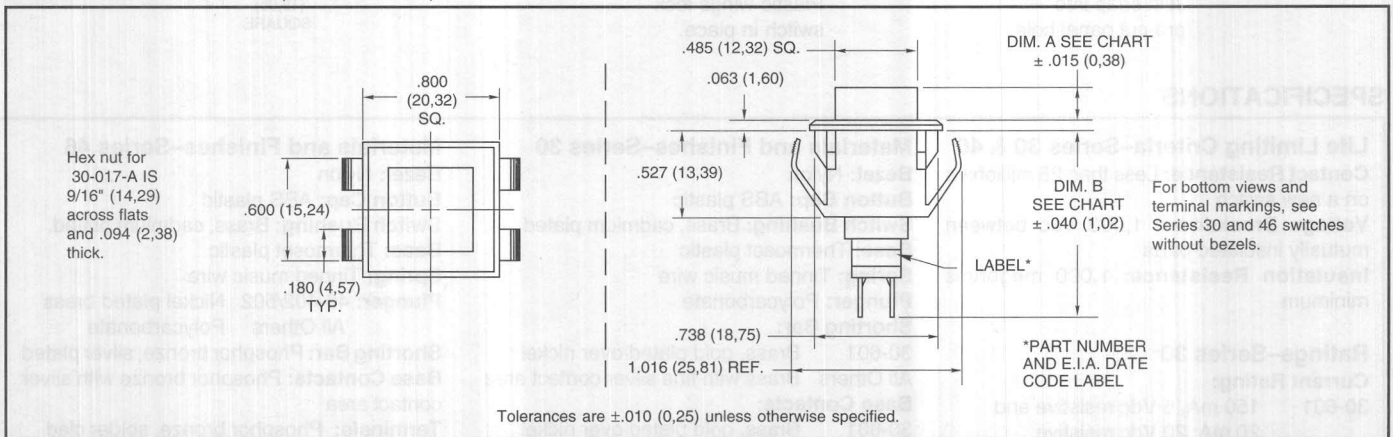
SERIES 30 AND SERIES 46 WITH PLASTIC SNAP-IN BEZELS

FEATURES

- Sleek Black Matte Bezel
- Convenient Snap-In Front Mount
- Choice of 6 Button Colors
- SPST, SPDT, or DPDT Circuitry
- Alternate Action, Positive Feel, and Overtravel Versions
- Printed Button Option

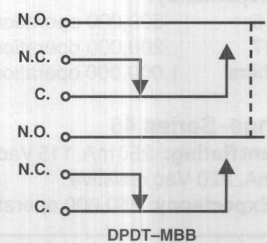
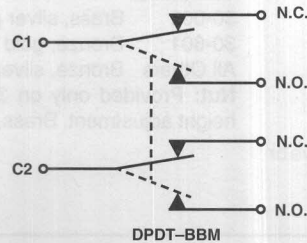
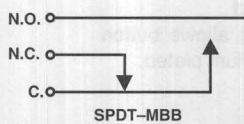
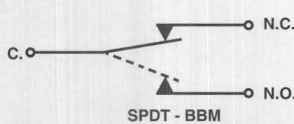


DIMENSIONS In Inches (and millimeters)



CIRCUITRY

Switches have momentary action unless otherwise indicated in the chart below.



ADDITIONAL DIMENSIONS AND PART NUMBERS

Circuitry and Features	Dim. A: Button Height (±.015)	Dim. B: Behind Panel Length (±.040)	Total Travel	Actuating Force	Partial Part No.*
Butt Contact Switches - Series 30					
SPST-N.O.	.205 (5,21)	1.119 (28,42)	.062 ± .010 (1,57 ± 0,25)	10 ± 4 oz.	30-001-A*
SPST-N.O., Overtravel	.205 (5,21)	1.204 (30,58)	.125 ± .020 (3,18 ± 0,51)	8 ± 4 oz.	30-015-A*
SPST-N.O., Overtravel & Positive Feel	Adjustable**	Adjustable**	.156 ± .015 (3,96 ± 0,38)	18 ± 4 oz.	30-017-A*
SPST-N.O., Economical	.205 (5,21)	1.119 (28,42)	.062 ± .010 (1,57 ± 0,25)	10 ± 4 oz.	30-601-A*
SPST-N.C.	.205 (5,21)	1.132 (28,75)	.065 ± .015 (1,65 ± 0,38)	8 ± 4 oz.	30-002-A*
Wiping Contact Switches - Series 46					
SPDT, BBM	.205 (5,21)	1.417 (35,99)	.180 (4,57) min.	1.1 ± .25 lbs.	46-102-A*
SPDT, MBB	.205 (5,21)	1.417 (35,99)	.180 (4,57) min.	1.1 ± .25 lbs.	46-111-A*
SPDT, BBM, Alternate Action	.293 (7,44)	1.448 (36,78)	.180 (4,57) min.	1.5 ± .25 lbs.	46-502-A*
DPDT, BBM	.205 (5,21)	1.448 (36,78)	.180 (4,57) min.	2.2 ± .5 lbs.	46-200-A*
DPDT, MBB	.205 (5,21)	1.448 (36,78)	.180 (4,57) min.	2.2 ± .5 lbs.	46-201-A*
DPDT, BBM, Alternate Action	.293 (7,44)	1.448 (36,78)	.180 (4,57) min.	1.8 ± .5 lbs.	46-402-A*

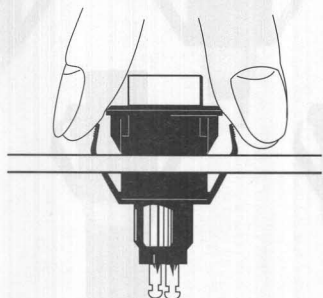
*Partial part number, complete part number by adding a dash for button color: white -01; red -03; green -04; blue -05; yellow -06 or black -07, see Ordering Information on page D-27.

**Adjustable from Dim. A .170 (4,32) min., Dim. B 1.285 (32,64) max. to Dim. A .290 (7,37) max., Dim. B 1.165 (29,59) min. with hex nut below bezel.

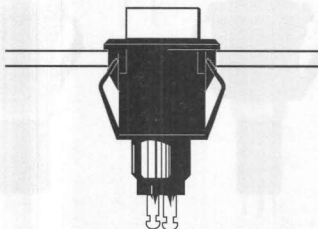
SNAP-IN PANEL MOUNT PUSHBUTTON SWITCHES

MOUNTING

Easy Snap-In Mounting



Just snap into pre-cut panel hole.

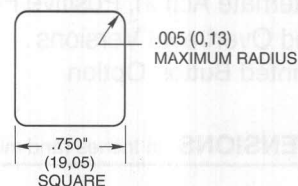


Plastic wings lock switch in place.

PANEL CUTOUT

Recommended Panel Cut

Switch will fit panels .049" (1,24) to .125" (3,18) thick. Recommended panel thickness is 18 gauge.



SPECIFICATIONS

Life Limiting Criteria—Series 30 & 46
Contact Resistance: Less than 25 milliohms on a new switch
Voltage Breakdown: 1,000 Vac between mutually insulated parts
Insulation Resistance: 1,000 megohms minimum

Ratings—Series 30

Current Rating:

30-601 150 mA, 5 Vdc resistive and 20 mA, 20 Vdc resistive
 All others 1 A, 115 Vac resistive, or 0.5 A, 220 Vac resistive

Life Expectancy:

30-015 500,000 operations
 30-017 200,000 operations
 All others 1,000,000 operations

Ratings—Series 46

Current Rating: 250 mA, 115 Vac resistive or 125 mA, 220 Vac resistive
Life Expectancy: 250,000 operations

Materials and Finishes—Series 30

Bezel: Nylon
Button Cap: ABS plastic
Switch Bushing: Brass, cadmium plated
Base: Thermoset plastic
Spring: Tinned music wire
Plunger: Polycarbonate
Shorting Bar:
 30-601 Brass, gold plated over nickel
 All Others Brass with fine silver contact area
Base Contacts:
 30-601 Brass, gold plated over nickel
 30-002 Brass with fine silver contact area
 All Others Bronze with fine silver contact area
Terminals:
 30-002 Brass, silver plated
 30-601 Bronze, gold plated over nickel
 All Others Bronze, silver plated
Nut: Provided only on 30-017; allows button height adjustment. Brass, cadmium plated.

Materials and Finishes—Series 46

Bezel: Nylon
Button Cap: ABS plastic
Switch Bushing: Brass, cadmium plated.
Base: Thermoset plastic
Spring: Tinned music wire
Plunger: 46-402/502 Nickel plated brass
 All Others Polycarbonate
Shorting Bar: Phosphor bronze, silver plated
Base Contacts: Phosphor bronze with silver contact area
Terminals: Phosphor bronze, solder clad
Covers (46-200/201): Brass, cadmium plated

STANDARD OPTIONS

Epoxy sealed terminals and wire leads, see page D-33.

LEGENDING OPTION

Contact Grayhill

A button legend can be printed in epoxy ink which bonds to the surface of the button cap. Any type style or design which can be photographed can be used to produce the legend.

There is a per-button printing charge. A nominal set up charge per legend applies to orders of 1 to 99 pieces. Non-standard legends are subject to one time artwork and tooling charges. Consult Grayhill for help with actual legend.

ORDERING INFORMATION

Use the partial part number you have selected from the Dimensions and Part Number chart, and add the button color suffix. Example:

46-200-A-03 **Color:** 01, 03, 04, 05, 06, 07

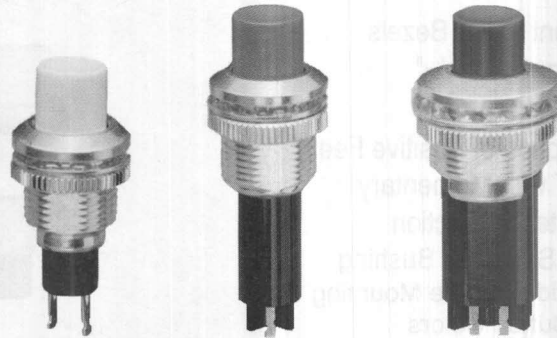
01 = White 03 = Red 04 = Green
 05 = Blue 06 = Yellow 07 = Black

DECORATOR LINE PUSHBUTTON SWITCHES

SERIES 30 AND 46-ROUND BEZEL

FEATURES

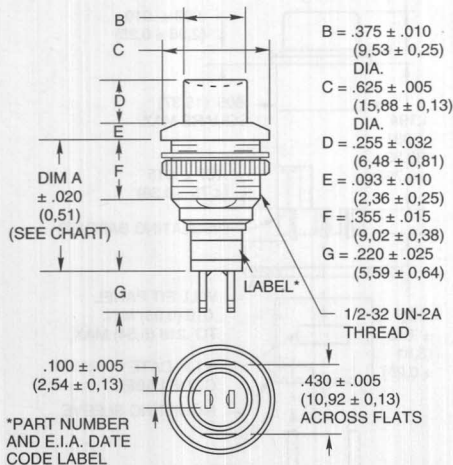
- Attractive Front Panel Bezels
- Space-Saving: Only 5/8 Inch Diameter (SPST & SPDT) and 3/4" Diameter (DPDT) Round Bezels
- SPST with Option of Positive Feel
- SPDT, DPDT with Momentary Contact or Alternate Action
- Sturdy Metal Sleeve or Bushing and Nut Provide Secure Mounting
- Choice of 6 Button Colors



DIMENSIONS In Inches (and millimeters)

SPST-Normally Open

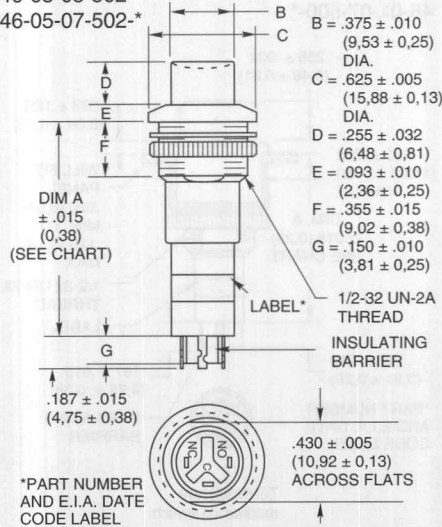
30-05-01-502-*
30-05-04-502-*



Feature	Partial Part No.	Dim. A
Standard	30-05-01-502-*	.710 (18,03)
Pos. Feel	30-05-04-502-*	.910 (23,11)

SPDT-Break Before Make

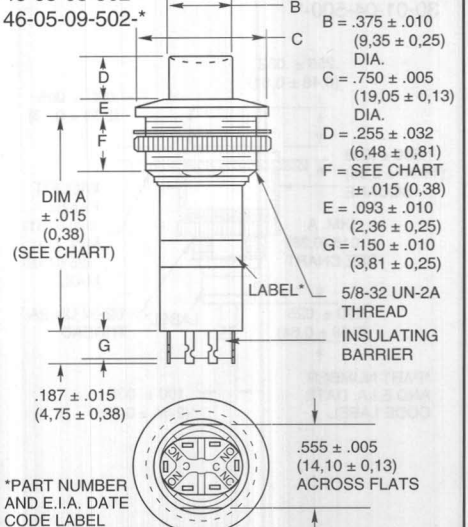
46-05-05-502-*
46-05-07-502-*



Feature	Partial Part No.	Dim. A
Standard	46-05-05-502-*	.992 (25,20)
Alt. Action	46-05-07-502-*	1.278 (32,46)

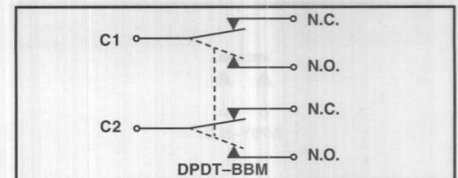
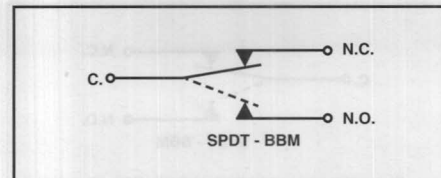
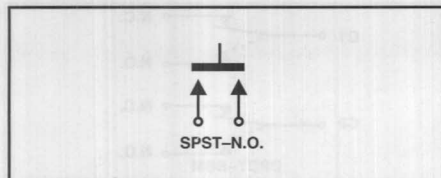
DPDT-Break Before Make

46-05-08-502-*
46-05-09-502-*



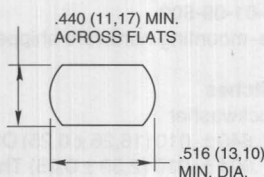
Feature	Partial Part No.	Dim. A	Dim. F
Standard	46-05-08-502-*	1.001 (25,43)	.314 (7,98)
Alt. Action	46-05-09-502-*	1.130 (28,70)	.355 (9,02)

CIRCUITRY

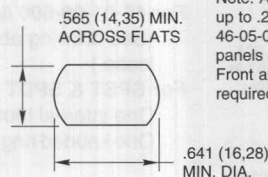


RECOMMENDED PANEL CUTOUT AND MOUNTING HARDWARE

SPST AND SPDT VERSION



DPDT VERSION



Note: All switches fit panels up to .250 (6,35) thick, except 46-05-08-502 which fits panels up to .187 (4,75) thick. Front and back panel access required for installation.

Mounting Hardware

For 46-05-08-502 & 46-05-09-502:

One internal tooth lockwasher
One knurled ring nut .765 \pm .010 (19,43 \pm 0,25) Dia.
.094 \pm .010 (2,39 \pm 0,25) Thk.

For SPST & SPDT switches

One internal tooth lockwasher
One knurled ring nut .640 \pm .010 (16,26 \pm 0,25) Dia.
.094 \pm .010 (2,39 \pm 0,25) Thk.

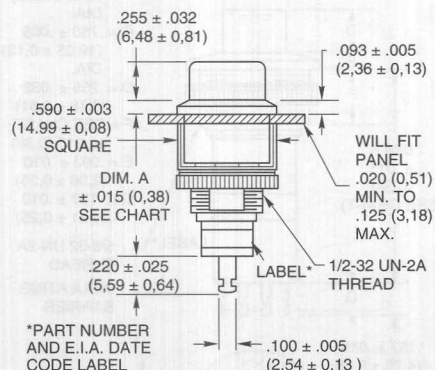
*Partial part number; complete part number by adding a dash for button color: white -01; red -03; green -04; blue -05; yellow -06 or black -07.

See page D-30 for specifications and ordering information.

DIMENSIONS In Inches (and millimeters)

SPST-Normally Open

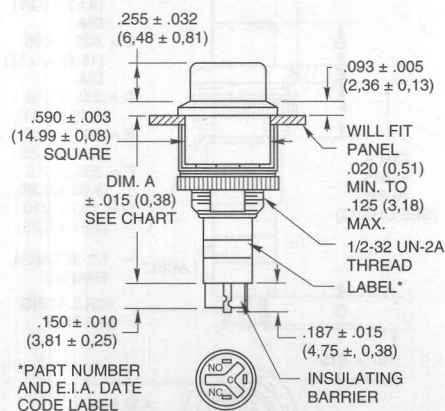
30-01-01-500-*
30-01-04-500-*



Feature	Partial Part No.	Dim. A
Standard	30-01-01-500-*	.880 (22,35)
Pos. Feel	30-01-04-500-*	1.037 (26,34)

SPDT-Break Before Make

46-01-05-500-*
46-01-07-500-*

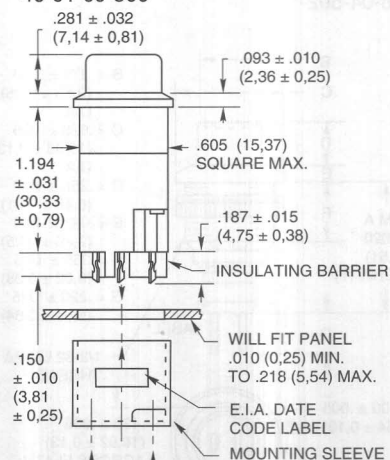


Terminals are marked on switch.

Feature	Partial Part No.	Dim. A
Standard	46-01-05-500-*	1.174 (29,82)
Alt. Action	46-01-07-500-*	1.264 (32,11)

DPDT-Break Before Make

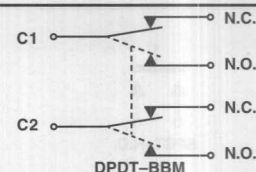
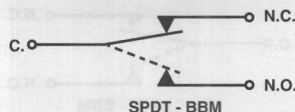
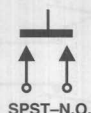
46-01-08-500-*
46-01-09-500-*



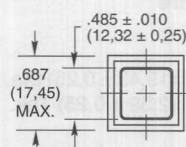
Terminals are marked on switch.

Feature	Partial Part No.
Standard	46-01-08-500-*
Alt. Action	46-01-09-500-*

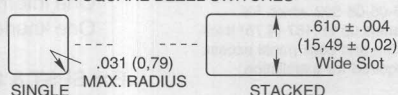
CIRCUITRY



FRONT VIEWS AND MOUNTING



RECOMMENDED PANEL CUTOUT FOR SQUARE BEZEL SWITCHES



Note: All switches fit panels up to .250 (6,35) thick.
Front and back panel access required for installation.

Mounting Hardware

For 46-01-08-500 & 46-01-09-500

(See drawing above—mounting hardware shipped loose.)

For SPST & SPDT switches

One internal tooth lockwasher

One knurled ring nut .640 ± .010 (16,26 ± 0,25) DIA.

.094 ± .010 (2,39 ± 0,25) Thk.

*Partial part number; complete part number by adding a dash for button color:
white -01; red -03; green -04; blue -05; yellow -06 or black -07.

DECORATOR LINE PUSHBUTTON SWITCHES

SPECIFICATIONS

Material and Finishes

Lockwasher (Round Bezel): Steel, Cadmium plated

Behind Panel Plate (Square Bezel): Steel, Cadmium plated

Mounting Sleeve and Screws (46-01-08-500, 46-01-09-500 only): Steel, Cadmium plated.

Base: Phenolic per MIL-M-14, Type CFG

Square Bezel: ABS (SPST, SPDT), Thermoset plastic (DPDT)

Mounting Nut, Bushing, and Round Bezel:

Brass, Cadmium plated (Except Bushing for Series 46, DPDT is Aluminum)

Button Cap: ABS

Shorting Bar: Series 30—Fine Silver contact area

Series 46—Phosphor Bronze, Silver plated

Terminals: Series 30—Fine Silver contact area with Silver plated terminal ends

Series 46—Silver contact surface with solder clad terminal ends

Spring: Tinned Music Wire

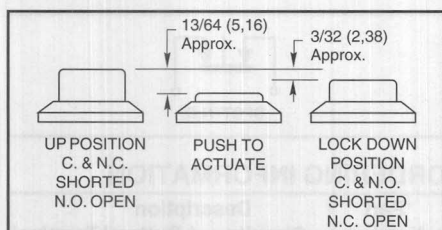
Plunger: Polyphenylene sulfide (PPS) for 30-01-01-500-X and 46-01-05-500-X. Nickel plated brass for 46-01-07-500-X, 46-05-07-502-X, 46-01-09-500-X and 46-05-09-502-X. Cadmium plated brass for 46-01-08-500-X. Polycarbonate for all others.

Operating Temperature: -40°C to +85°C

ALTERNATE ACTION (PUSH-PUSH) OPERATING SEQUENCE

Part Number* 46-05-07-502, 46-05-09-502, 46-01-07-500, 46-01-09-500

Alternate action (Push-Push) switches provide a maintained actuated position until the button is pushed again to release.



STANDARD OPTIONS

Epoxy sealed terminals and wire leads, see page D-33.

RATINGS

Electrical Ratings	Series 30	Series 46
Contacts	Butt type	Wiping type
Rating at 115 Vac Res.	1 Amp	0.25 Amp
Rating at 220 Vac Res.	0.5 Amp	0.125 Amp
Circuitry	SPST-N.O. (Standard); SPST-N.O. (w/Overtravel), SPST-N.O. (w/Positive Feel)	SPDT, DPDT Break Before Make
Life Expectancy	SPST-N.O. (Standard): 1,000,000 operations SPST-N.O. (w/Positive Feel): 200,000 operations; SPST-N.O. (w/Overtravel): 500,000 operations	250,000 operations
Contact Resistance	25 milliohms or less on a new switch	
Voltage Breakdown	1000 Vac between mutually insulated parts	
Insulation Resistance	1000 megohms minimum	
Operating Temperature	-40°C to +85°C	

LEGENDS

All button caps can be printed in epoxy ink. Any type style or design can be used to produce the legend. If News Gothic Condensed style is used, limits can be approximated from the chart below; actual limits depend on specific legend.

There is a per-button impression charge. A nominal set up charge per legend applies to orders of 1 to 99 pieces. (Non-standard legends are subject to a one time tooling charge. Contact Grayhill for more specifics.)

Grayhill Type Identification No.	Character Height (Typ.)	Sample Style and Sizes	Square Button Character and Line Limitation		Round Button Character and Line Limitation	
4GH088	.083 (2,1)	ABCDEFGHIJ	6 Char. 3 Lines	TAB LOCATE	3 Char. 1 Line	OFF
1GH125	.138 (3,5)	ABCDEFGHIJ	5 Char. 2 Lines	INDEX	3 Char. 1 Line	TAB
3GH187	.207 (5,3)	ABCDEF	3 Char. 1 Line	OFF	2 Char. 1 Line	15
2GH250	.276 (7,0)	ABCD	2 Char. 1 Line	15	N/A	N/A

ORDERING INFORMATION & OPERATING FEATURES

	Square Bezel	Round Bezel	Circuitry	Feature	Total Travel	Bottoming Force	Actuating Force	Overtravel
Butt Contact	30-01-01-500-*	30-05-01-502-*	SPST-N.O.	Momentary	.080 ± .015 (2,03 ± 0,38)	—	10 ± 4 oz.	—
	30-01-04-500-*	30-05-04-502-*	SPST-N.O.	Positive Feel & Overtravel	.156 ± .015 (3,96 ± 0,38)	—	18 ± 4 oz.	.046 Min.
Wiping Contact	46-01-05-500-*	46-05-05-502-*	SPDT	Momentary	.180 min. (4,57)	1.1 ± .25 Lbs.	—	—
	46-01-07-500-*	46-05-07-502-*	SPDT	Alternate Action	.210 ± .015 (5,33 ± 0,38)	1.5 ± .25 Lbs.	—	—
	46-01-08-500-*	46-05-08-502-*	DPDT	Momentary	.180 min. (4,57)	1.6 ± .5 Lbs.	—	—
	46-01-09-500-*	46-05-09-502-*	DPDT	Alternate Action	.210 ± .015 (5,33 ± 0,38)	1.8 ± .5 Lbs.	—	—

*Partial part number; complete the part number by adding a dash for button color: white -01; red -03; green -04; blue -05; yellow -06 or black -07.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

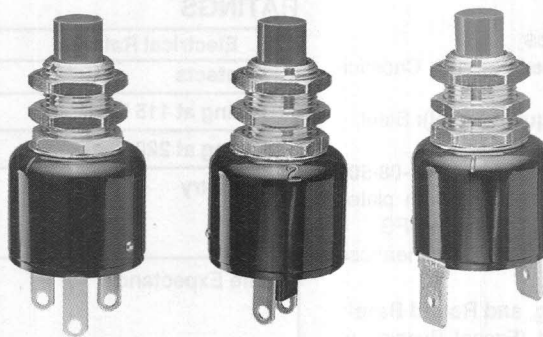


10 AMP SNAP ACTION PUSHBUTTON SWITCHES

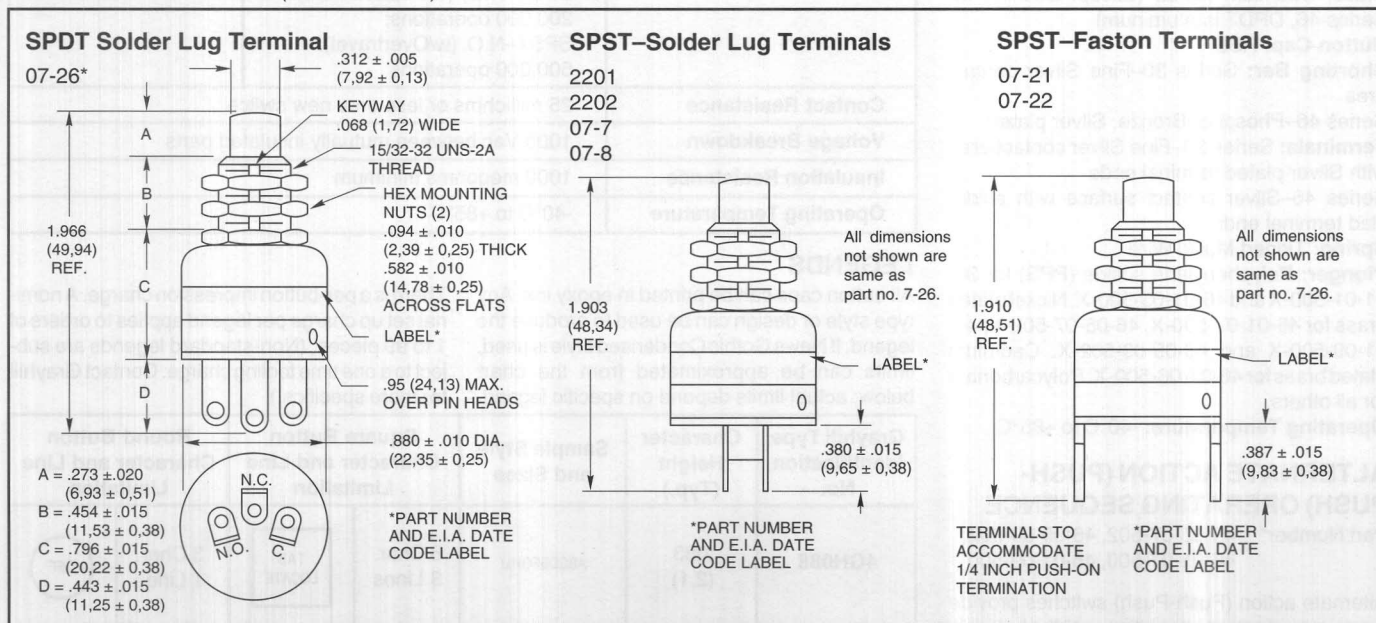
SERIES 7 SERIES 2000

FEATURES

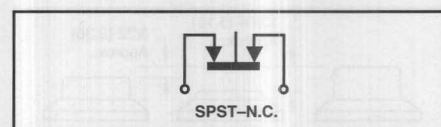
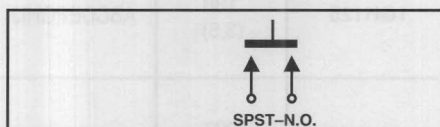
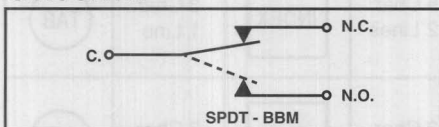
- Momentary Contact
- Extremely Fast Make and Break
- Audible Click
- 25,000 Cycles of Operation



DIMENSIONS In Inches (and millimeters)



CIRCUITRY



SPECIFICATIONS

Rating Criteria

Rated: To make and break 10 Amps at 115 Vac, or 5 Amps at 220 Vac resistive load for 25,000 operations

Contact Resistance: 25 milliohms or less on a new switch

Voltage Breakdown: 1,000 Vac between mutually insulated parts

Insulation Resistance: 1,000 megohms minimum

Operating Features

Total Button Travel: .065 (1.65) approximately

Overtravel: .008 (0.20) approximately

Actuating Force: 24 ounces approximately.

Mounting Hole: 31/64" (12.30) inches

Terminal Type: Solder

Operating Temperature: -40°C to +85°C

Materials and Finishes

Housing, Button and Internal Bridge: Thermoset plastic

Mounting Nuts, Bushings, Terminals and Internal Bracket: Steel, cadmium plated

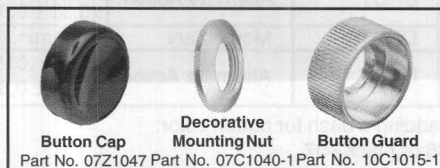
Fixed and Moving Contacts: Fine silver

Internal Spring, Link and Contact Carrier: Beryllium, copper

Cover-to-Base Mounting Pins: Brass

Faston Terminals: Brass, tin plated

ACCESSORIES



ORDERING INFORMATION

*Part Number	Description	Circuitry	Button	Terminal
2201	SPST-N.O.	Red	Solder	Solder
07-7	SPST-N.O.	Black	Solder	Solder
07-21	SPST-N.O.	Black	Faston	Faston
2202	SPST-N.C.	Black	Solder	Solder
07-8	SPST-N.C.	Red	Solder	Solder
07-22	SPST-N.C.	Black	Faston	Faston
07-26 RED	SPDT-BBM	Red	Solder	Solder
07-26 BLK	SPDT-BBM	Black	Solder	Solder

Part Number	Accessory Description
07Z1047-1 BLK	Black Button Cap
07Z1047-2 RED	Red Button Cap
07C1040-1	Decorative Nut
10C1015-1	Button Guard

For accessory dimensions and materials, see page D-34.

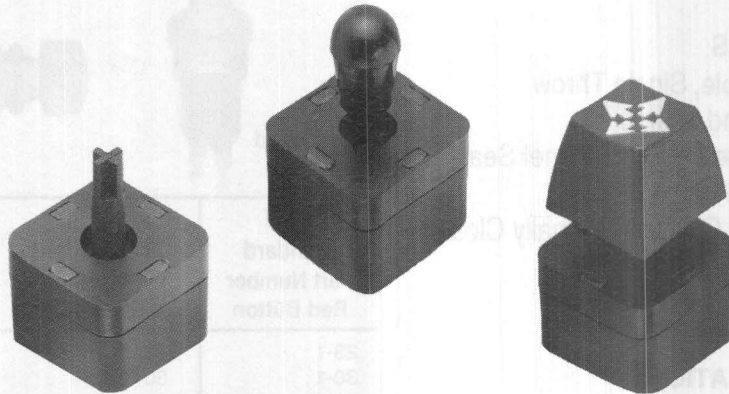
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

FOUR WAY JOYSTICK ACTION SWITCHES

SERIES 4

FEATURES

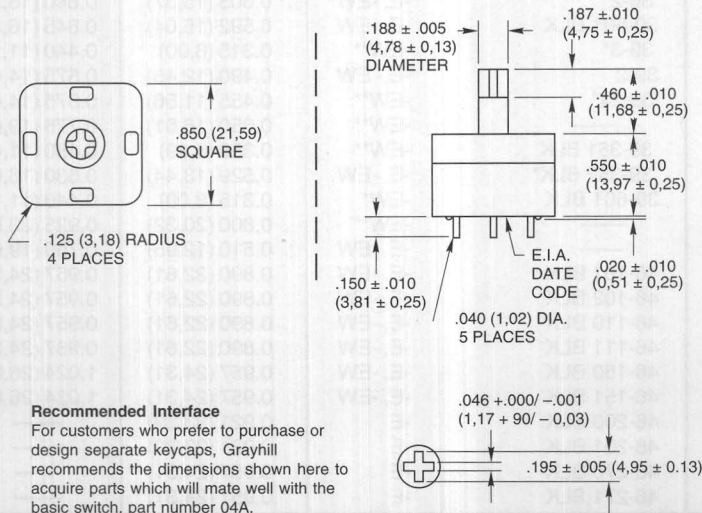
- Position Locator On CRT Screens
- Moves Cursor On Menu Display



DIMENSIONS In Inches (and millimeters)

Basic Switch

04A

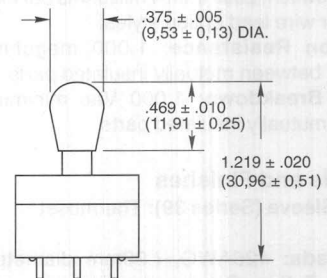


Recommended Interface

For customers who prefer to purchase or design separate keycaps, Grayhill recommends the dimensions shown here to acquire parts which will mate well with the basic switch, part number 04A.

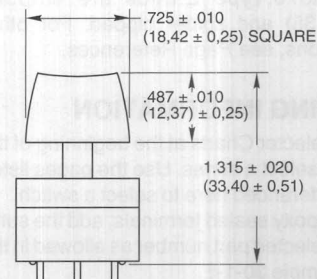
Bat Handle

04A-B01



Keycap

04A-K01



SPECIFICATIONS

Rating Criteria

Rated: Make and break 250 mA at 115 Vac or 125 mA at 220 Vac resistive load for 500,000 operations

Contact Resistance: 25 milliohms maximum on a new switch

Insulation Resistance: 1,000 megohms at 100 Vdc

Dielectric Strength: 500 Vac RMS minimum

Operating Temperature: -40°C to +85°C

Materials and Finishes

Base, Cover and Switch Actuator: Polyester (Black)

Terminals: Brass, gold plated over nickel

Shorting Bar: Phosphor bronze, gold plated over nickel

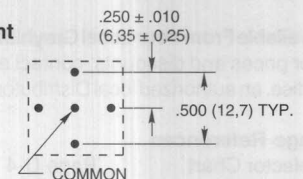
Spring: Tinned music wire

Keycap: ABS or equivalent

Bat-Handle: ABS

CIRCUITRY

Footprint



ORDERING INFORMATION

Description	Part No.
Basic Switch	04A
Switch with Arrowhead Keycap	04A-K01
Switch with Bat-Handle	04A-B01*

*Shipped with bat handle permanently attached.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SEALED TERMINAL AND WIRE LEAD OPTIONS FOR PUSHBUTTON SWITCHES

OPTION -E AND -EW

FEATURES

- Single Pole, Single Throw
- 1/4, 1/2, and 1 Amp
- Limit, Overtravel, or Panel Seal
- Butt or Wiping Contact
- Normally Open or Normally Closed
- Momentary or Push/Pull
- Series 23, 30, 39 and 46

SPECIFICATIONS

Rating Criteria

Make and Break Current Rating: See page for standard part number

Contact Resistance: 25 milliohms maximum on a new switch. Less than 4 milliohms per inch of wire for wire lead option styles.

Insulation Resistance: 1,000 megohms minimum between mutually insulated parts

Voltage Breakdown: 1,000 Vac minimum between mutually insulated parts

Materials and Finishes

Potting Sleeve (Series 39): Thermoset Plastic

Wire Leads: #26AWG, (.99mm diameter) insulated Teflon, Copper stranded wire, per MIL-W-16878, Type E. Ends are stripped 0.250" (6.35) and solder dipped. For other specifications, see Page References.

ORDERING INFORMATION

Use the Selector Charts at the beginning of the section to select a series. Use the pages listed there or referenced here to select a switch.

To order epoxy sealed terminals, add the suffix -E to the selected part number as allowed in the chart. Example 30-1-E.

To order the epoxy potted version with 6 inch wire leads, use the suffix -EW as allowed in the chart.

Example: 39-1-EW.

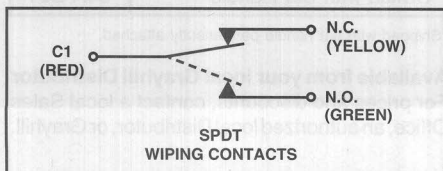
Available From Your Local Grayhill Distributors

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

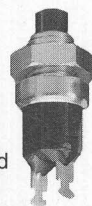
Page References

Selector Chart	Page D-4
Series 23	Page D-24
Series 30	Pages D-17 to D-20, and D-26 to D-30
Series 39	Pages D-11 to D-16
Series 46	Pages D-21 to D-23 and D-26 to D-30

CIRCUITRY—Series 46



Option -E
Epoxy Sealed
Terminals



Option -EW,
Potted Base & 6"
Wire Leads



Standard Part Number Red Button	Standard Part Number Black Button	Choices of Suffix	Length Behind Panel In inches (and millimeters)	
			Standard Switch & Terminals	-EW Style Body
23-1	23-4	-E, -EW	0.665 (16,89	0.693 (17,60)
30-1	30-3	-E, -EW	0.592 (15,04)	0.645 (16,38)
30-15	30-37	-E, -EW	0.679 (17,25)	0.728 (18,49)
30-17 RED	30-17 BLK	-E, -EW	0.958 (24,33)	1.007 (25,58)
30-16 RED	30-16 BLK	-E, -EW	0.958 (24,33)	1.007 (25,58)
30-251 RED	30-251 BLK	-E, -EW	0.632 (16,05)	0.685 (17,40)
30-252 RED	30-252 BLK	-E, -EW	0.645 (16,38)	0.700 (17,78)
30-32 RED	30-32 BLK	-E, -EW	0.867 (22,02)	0.896 (22,76)
30-6	30-2	-E, -EW	0.605 (15,37)	0.640 (16,26)
30-601 RED	30-601 BLK	-E, -EW	0.592 (15,04)	0.645 (16,38)
39-1* ——	39-3* 39-2	-EW** -E, -EW	0.315 (8,00) 0.490 (12,45)	0.440 (11,18) 0.575 (14,61)
39-12* 39-101	39-24* ——	-EW** -EW**	0.455 (11,56) 0.650 (16,51)	0.575 (14,61) 0.775 (19,69)
39-351 RED	39-351 BLK	-EW**	0.350 (8,89)	0.450 (11,43)
39-352 RED*	39-352 BLK*	-E, -EW	0.529 (13,44)	0.630 (16,00)
39-601 RED	39-601 BLK	-EW*	0.315 (8,00)	0.440 (11,18)
39-701***	——	-EW**	0.800 (20,32)	0.925 (23,50)
39-702***	——	-E, -EW	0.510 (12,95)	0.750 (19,05)
46-101 RED	46-101 BLK	-E, -EW	0.890 (22,61)	0.957 (24,31)
46-102 RED	46-102 BLK	-E, -EW	0.890 (22,61)	0.957 (24,31)
46-110 RED	46-110 BLK	-E, -EW	0.890 (22,61)	0.957 (24,31)
46-111 RED	46-111 BLK	-E, -EW	0.890 (22,61)	0.957 (24,31)
46-150 RED	46-150 BLK	-E, -EW	0.957 (24,31)	1.024 (26,01)
46-151 RED	46-151 BLK	-E, -EW	0.957 (24,31)	1.024 (26,01)
46-200 RED	46-200 BLK	-E	0.921 (23,39)	——
46-201 RED	46-201 BLK	-E	0.921 (23,39)	——
46-270 RED	46-270 BLK	-E	0.957 (24,31)	——
46-271 RED	46-271 BLK	-E	0.957 (24,31)	——
Standard Part Number Choice of Button Color (see switch pages)	Standard Part Number Without Options Choice of Button Color (see switch pages)	Choices of Suffix	Length Behind Panel In inches (and millimeters) Standard Switch & Terminals	-EW Style Body
30-001-A-XX	——	-E, -EW	1.119 (28,42)	1.172 (29,77)
30-002-A-XX	——	-E, -EW	1.132 (28,75)	1.167 (29,64)
30-015-A-XX	——	-E, -EW	1.204 (30,58)	1.253 (31,83)
30-017-A-XX	——	-E, -EW	Adjustable†	Adjustable†
30-1-1-50-XX	30-01-01-500-XX	-E, -EW	1.100 (27,94)	1.153 (29,29)
30-1-4-50-XX	30-01-04-500-XX	-E, -EW	1.257 (31,93)	1.310 (33,27)
30-5-1-52-XX	30-05-01-502-XX	-E, -EW	0.930 (23,62)	0.983 (24,97)
30-5-4-52-XX	30-05-04-502-XX	-E, -EW	1.130 (28,70)	1.183 (30,05)
30-601-A-XX	——	-E, -EW	1.119 (28,42)	1.172 (29,77)
46-1-5-50-XX	46-01-05-500-XX	-E, -EW	1.361 (34,57)	1.428 (36,27)
46-1-7-50-XX	46-01-07-500-XX	-E, -EW	1.451 (36,86)	1.518 (38,56)
46-1-8-50-XX	46-01-08-500-XX	-E	1.381 (35,08)	——
46-1-9-50-XX	46-01-09-500-XX	-E	1.381 (35,08)	——
46-5-5-52-XX	46-05-05-502-XX	-E, -EW	1.179 (29,95)	1.246 (31,65)
46-5-7-52-XX	46-05-07-502-XX	-E, -EW	1.465 (37,21)	1.532 (38,91)
46-5-8-52-XX	46-05-08-502-XX	-E	1.188 (30,18)	——
46-5-9-52-XX	46-05-09-502-XX	-E	1.317 (33,45)	——
46-102-A-XX	——	-E, -EW	1.417 (35,99)	1.484 (37,69)
46-111-A-XX	——	-E, -EW	1.417 (35,99)	1.484 (37,69)
46-200-A-XX	——	-E	1.448 (36,78)	——
46-201-A-XX	——	-E	1.448 (36,78)	——

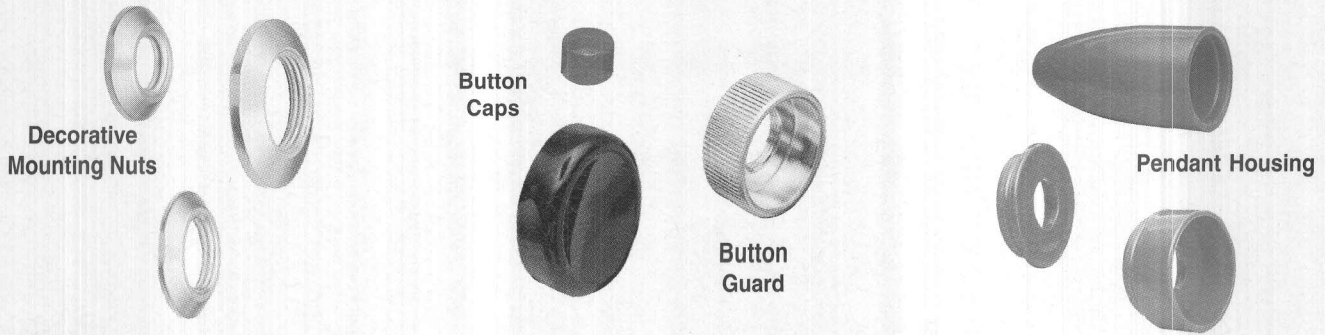
*Epoxy potting sleeve enlarges the diameter of the -EW style to 0.300 (7,62).

**Sealed terminal (-E) option is not necessary; terminals have sealed construction.

***Natural Color Button

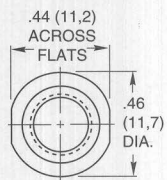
†Adjustable from 1.214 (30,84) to 1.334 (33,88) dependent on button height, see switch pages.

ACCESSORIES FOR PUSHBUTTON SWITCHES



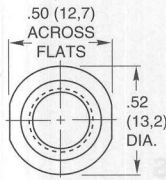
DIMENSIONS In Inches (and millimeters)

Decorative Mounting Nuts



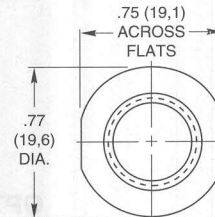
30C1023-1

Brass, nickel plated for 1/4" (6,35) bushing.



23C1024-1

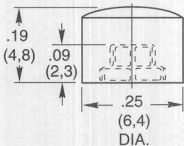
Brass, nickel plated for 5/16" (7,93) bushing.



07C1040-1

Brass, nickel plated for 15/32" (11,9) bushing.

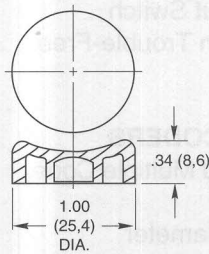
Button Caps and Guard



30B1012

Thermosetting plastic (Fasten to button with adhesive, Eastman 910 or equivalent) black, red or white.

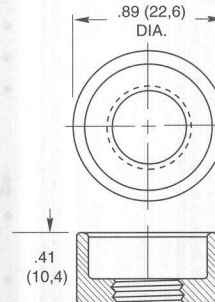
For use with all Series 30 and 39 switches except part number 39-101. See switch pages.



07Z1047

Thermoplastic, black, or red color.

For use with Series 2000 and Series 7 switches. See switch pages.



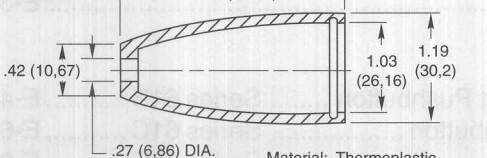
10C1015-1

Brass, cadmium plated for 15/32" (11,9) bushing.

Remote Switching Accessories Pendant Housing and Caps

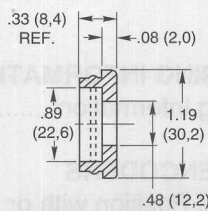
07Z4950

07Z5051



Housing

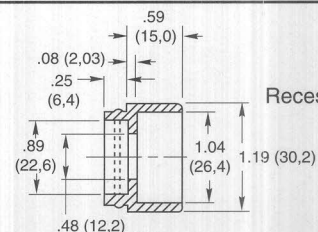
Material: Thermoplastic
Specials: other colors available on special order.



Flat Cap

Application:

All grayhill pushbutton switches with 15/32-32 bushings: catalog numbers 2201, 2202, 07-7, 07-8, 07-21, 07-22, 07-26, 4001, 4002, 10-9, 10-10, 10-100, 10-101, 30-16, 30-17 and 30-32. any other switch with 15/32-32 bushing if it fits housing.



Recessed Cap

ORDERING INFORMATION

Mounting Nuts, Button Caps, and Guards

Part Number	Color
07C1040-1	Decorative Nut
23C1024	Decorative Nut
30C1023-1	Decorative Nut
07Z1047-1 BLK	Black Button Cap
07Z1047-2 RED	Red Button Cap
10C1015-1	Button Guard
30B1012-5	Red Cap
30B1012-8	White Cap
30B1012-9	Black Cap

Pendant Housing and Caps

Part Number	Description
07Z4950 RED	Red Flat Cap & Housing
07Z4950 BLK	Black Flat Cap & Housing
07Z5051 RED	Red Rcstd Cap & Housing
07Z5051 BLK	Black Rcstd Cap & Housing

Sold only as sets of one housing and one cap.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

OPTICAL ENCODERS

- Eliminates Rotary Mechanical Contacts
- Accurate 32 Position Resolution
- Logic Compatible
- Selects Menu or Display Items
- Includes Data Input Switch
- More than 1 Million Trouble-Free Cycles

MECHANICAL ENCODERS

- Standard BCD and Multiple Code Outputs
- As Small as 1/2" Diameter
- Economical Means to Provide Code Output

ENGINEERING INFORMATION

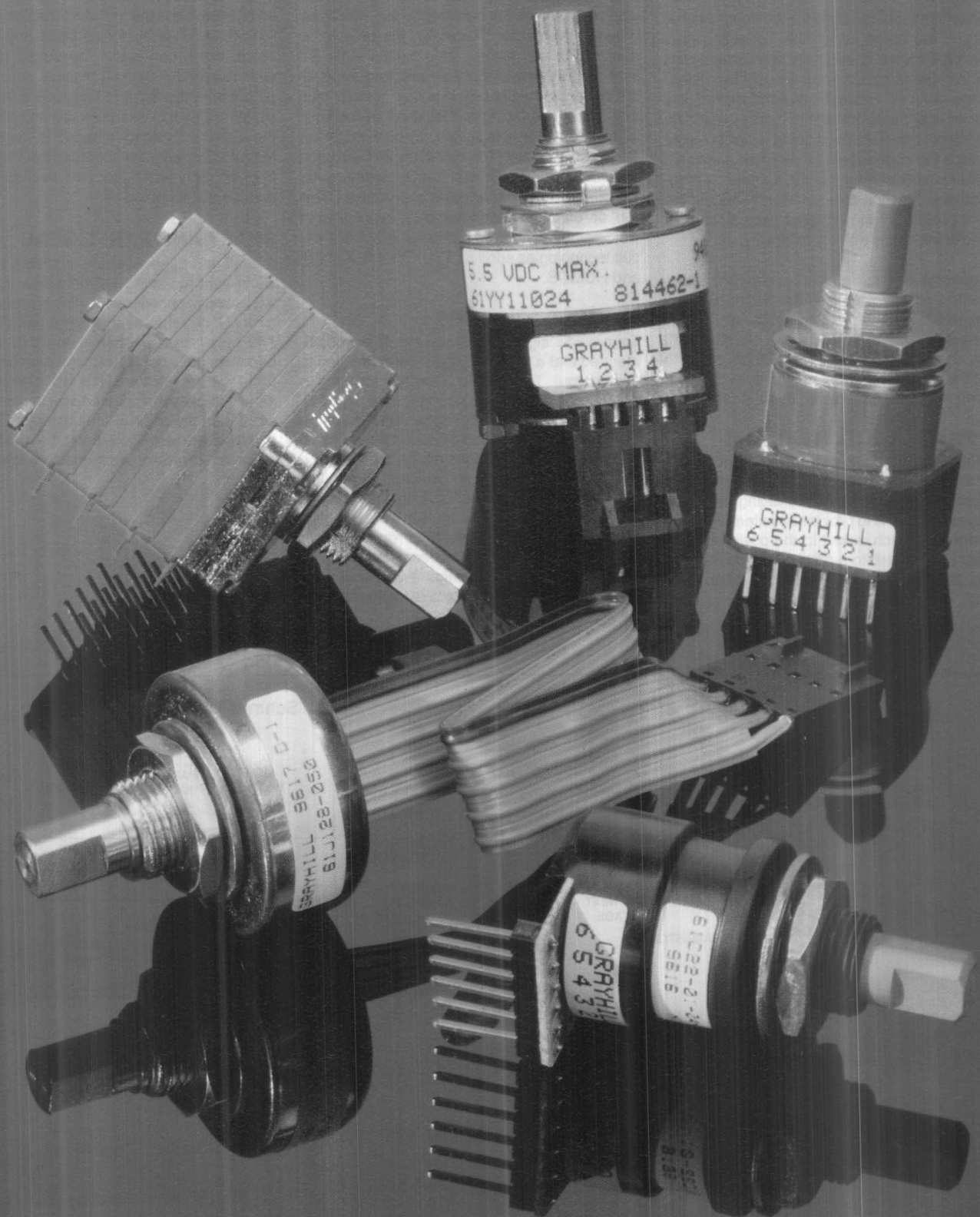
Engineering Information E-3

OPTICAL ENCODERS

16, 24 or 32 Position with or without Pushbutton Series 61B E-4
 16 or 32 Position with Integral Pushbutton Series 61C E-6
 High End Custom Series 61D E-8
 High Resolution, 4 Pin Series 61H E-10
 High Resolution, 5 Pin Series 61J E-12

MECHANICAL ENCODERS

Multiple Code and Indexing Options Series 25 E-15
 1/2" Diameter Binary Coded Series 26 E-17
 1/2" Diameter BCD and Complement Binary Coded Series 51 E-18
 1/4 Amp BCD Binary Coded Series 71 E-20



QUADRATURE

All Grayhill encoders use quadrature output code, which is the same as a 2-bit, repeating gray code. Quadrature is the most popular and cost effective output format because only two detectors are required. However, quadrature can only be used in applications where incremental data is required. Absolute positioning is not possible because the code repeats every four positions. In other words, changes in the encoder in magnitude and direction can be determined, but the actual position of the encoder cannot. In most applications this is not a problem.

In a quadrature rotary optical encoder two detectors are used to provide outputs, "A" and "B". The code rotor either blocks the infrared light or allows it to pass to the detectors. As the shaft turns the rotor, the outputs change state to indicate position. The resulting output is two square waves which are 90° out of phase.

OPEN COLLECTOR OUTPUT

The open collector output is typical of the Series 61B and 61C and is the simplest form of output available. The first step in interfacing with open collector outputs is to provide an external pull-up resistor from each output to the power source. These pull-up resistors provide the output with the high state voltage when the phototransistor is "off".

In a phototransistor, base current is supplied when light strikes the detector, which effectively grounds the output. Typically, the detector is operated in saturation. This means sufficient light is provided to completely sink, or ground, all the current provided by the pull up resistor plus that of the interfacing electronics. In the logic high state, the light is sufficiently blocked by the rotor and the detector functions like an open circuit. The pull up resistor then provides sourcing current to the interfacing electronics. This "on" or "off" digital arrangement allows the open collector to interface with popular integrated circuit technologies such as TTL, TTL LS, CMOS, and HCMOS.

SCHMITT TRIGGERS

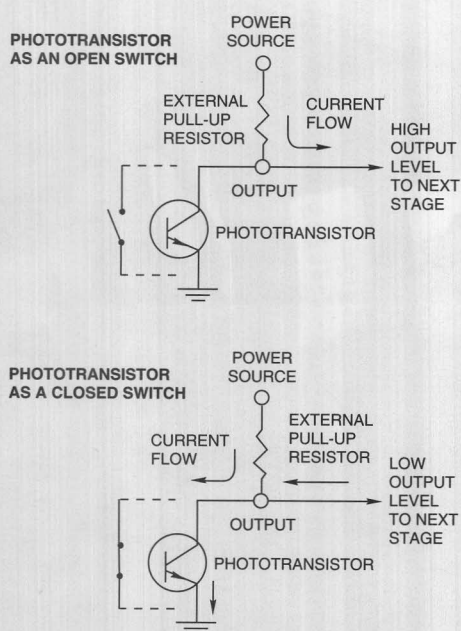
To provide signal enhancement it is recommended that a Schmitt Trigger be connected to each output. This device is already included in the Series 61H and 61J encoder (see pages E-12 to E-16). The Schmitt Trigger "cleans up" the output into a pure digital signal. It does this by removing the small linear region between the "on" and "off" states of the detector. During this transition the light is only partially blocked and the output is somewhere between what the interfacing circuit might consider to be "on" or "off". In other words, the output is not completely digital. The Schmitt Trigger contains a very important feature which makes it attractive for this applica-

tion. The device has a higher threshold, or trigger level, when it is in the "on" state than it does in the "off" state. This hysteresis filters any electrical noise, which can cause the output to change state rapidly during the transition. And since the output from the Schmitt Trigger is a pure digital signal and is isolated from the phototransistor, the signal is basically immune to loading problems that can effect encoders without the Schmitt Trigger. Schmitt Triggers are available in most popular IC technologies.

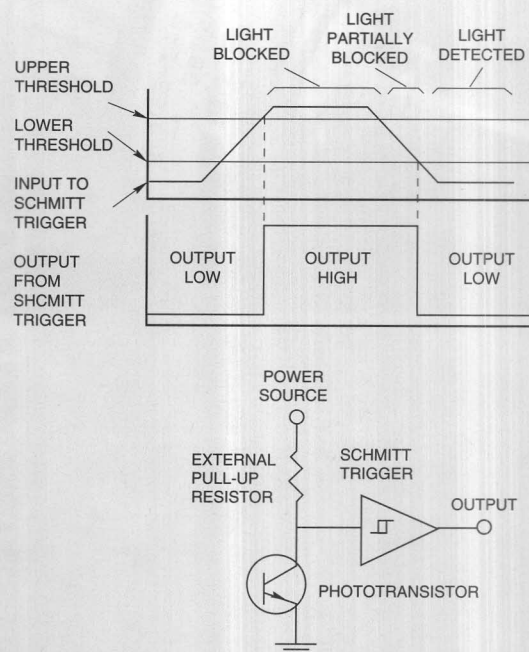
SHAFT AND PANEL SEAL

A shaft and panel seal are available to provide water-tight mounting for the Series 61B, 61D, 61H and 61J encoders. Sealing is accomplished by an "O" ring shaft seal and a panel seal washer. The panel seal washer in the 61B and 61D encoders does not affect the overall dimensions of the switches. In the 61H and 61J encoders, the .045" thick washer is placed over the threads and sits flat on the base of the bushing. The 61HS and 61JS are also epoxy sealed on the bottom of the switch to provide a completely sealed switch.

Open Collector Output



Schmitt Trigger



SERIES 61B 16, 24 or 32 Positions With or Without Pushbutton

FEATURES

- Positions Screen Cursor
- More Friendly than Keyboards
- Permits Visual Concentration
- Economic Touchscreen Alternative
- Pushbutton for Entry Function
- Detent for Tactile Feedback and Minimal Backlash
- Optical Coupling for Long Life
- Rugged Construction

APPLICATIONS

Display Input

The Series 61 rotary encoder switch can move cursor or icon on a display. Use the rotary and pushbutton switch to simply select a menu item and enter it, or write more elaborate display software. Use the Series 61 to input limit settings for a monitored function. Change an item on a

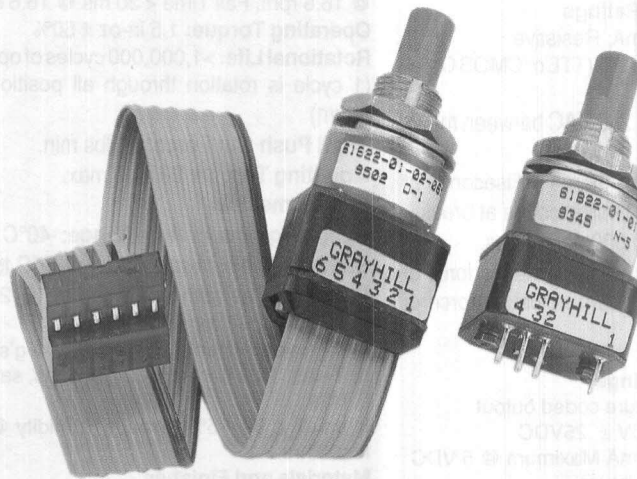
checklist to a new value while viewing the remainder of the list.

Incremental Input

Use the Series 61 with an interface chip to provide step by step input for setting radio frequency, drill depth, RPM, etc. These changes

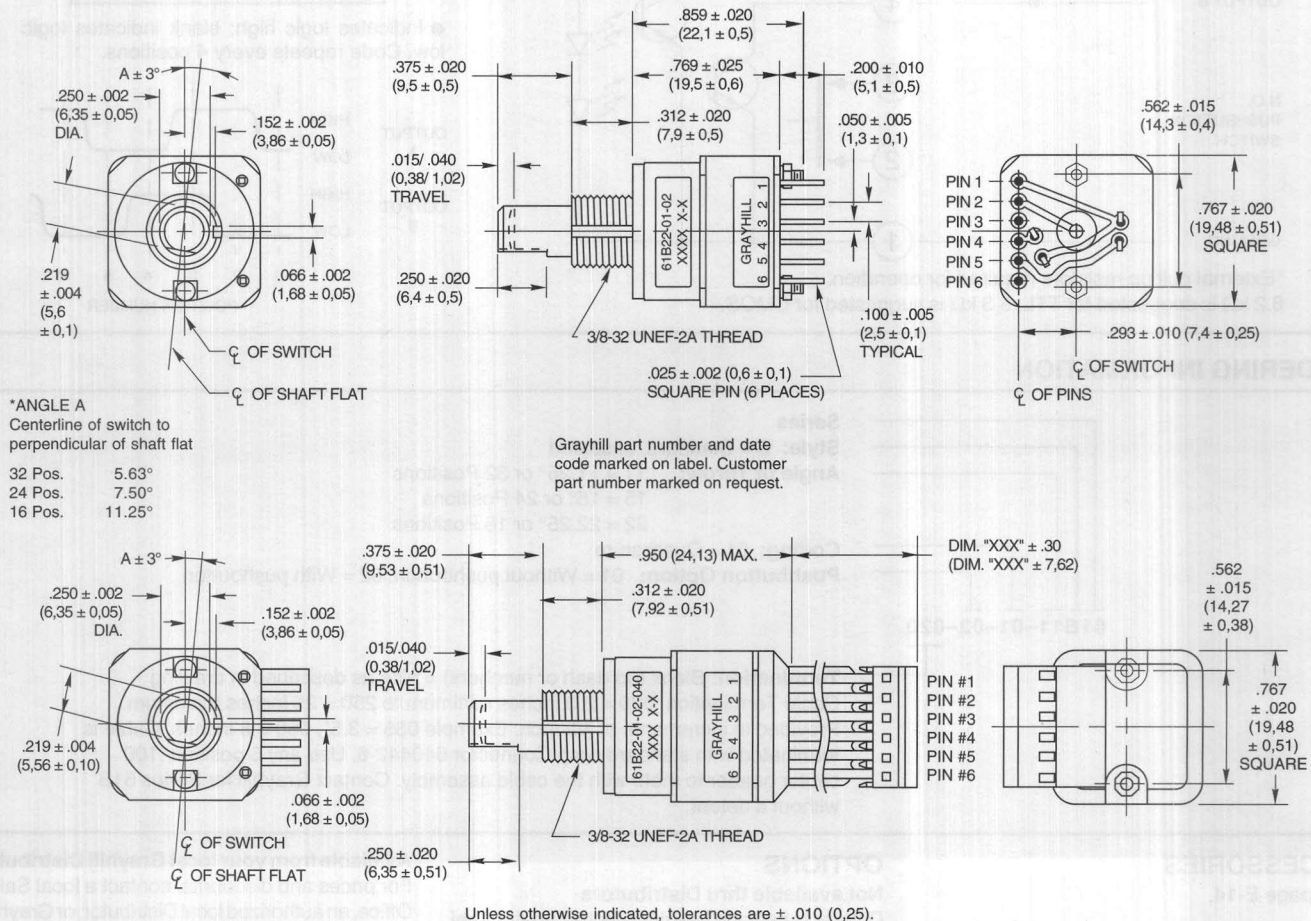
are usually a few steps, and you need not turn the switch several revolutions for the desired value. Some examples are as follows:

- Robot Position
- Volume Setting
- Radio Tuning
- Limit Setting
- Motor Control



DIMENSIONS In inches (and millimeters)

Diagram illustrates a 16-position switch with integral pushbutton switch.



OPTICAL ENCODERS

SPECIFICATIONS

Pushbutton Switch Ratings

Rating: at 5 Vdc, 10 mA, Resistive

Contact Resistance: <10 (TTL or CMOS Compatible)

Voltage Breakdown: 250 VAC between mutually insulated parts.

Contact Bounce: Less than 4 milliseconds at make and less than 10 milliseconds at break.

Actuation Life: 3,000,000 operations.

Actuation Force: Maximum actuation force of 450 grams and a minimum actuation force of 300 grams.

Rotary Encoder Ratings

Coding: 2 bit quadrature coded output.

Operating Voltage: 5V \pm .25VDC

Supply Current: 30 mA Maximum @ 5 VDC

Logic High: 3.8V Minimum

Logic Low: 0.8V Maximum

Logic Rise and Fall Times: Rise Time < 30 ms @ 16.6 rpm. Fall Time < 30 ms @ 16.6 rpm.

Operating Torque: 1.5 in-oz \pm 50%

Rotational Life: >1,000,000 cycles of operation (1 cycle is rotation through all positions and return)

Shaft Push Out Force: 50 lbs min.

Mounting Torque: 20 in-lb max.

Environmental

Operating Temperature Range: -40°C to 65°C

Storage Temperature Range: -40°C to 65°C

Vibration Resistance: Tested at 10–2000 Hz at 15g or 0.060" double amplitude.

Mechanical Shock: Tested at 100 g's, 6 ms, half sine, 12.3 ft/s and 100 g's, 6 ms, sawtooth, 9.7 ft/s.

Humidity: 90–95% Relative Humidity @ 40° C for 96 hrs.

Materials and Finishes

Detent Cover: Thermosetting plastic

Bushing: Zinc casting, Cadmium plated per QQP-416, Class 2, Type II

Shaft: Reinforced thermoplastic

Note: Earlier versions may have electropolished stainless steel shafts. (Still available in customs only)

Detent Balls: Steel, nickel plated

Detent Spring: Tinned music wire

PC Boards: NEMA Grade FR-4

Board Terminals: Copper alloy, CDA No. 725

Through Bolts: Stainless steel, unplated

Through Bolt Nuts: Stainless steel

Switch Assembly Cover and Code Rotor: PBT polyester thermoplastic

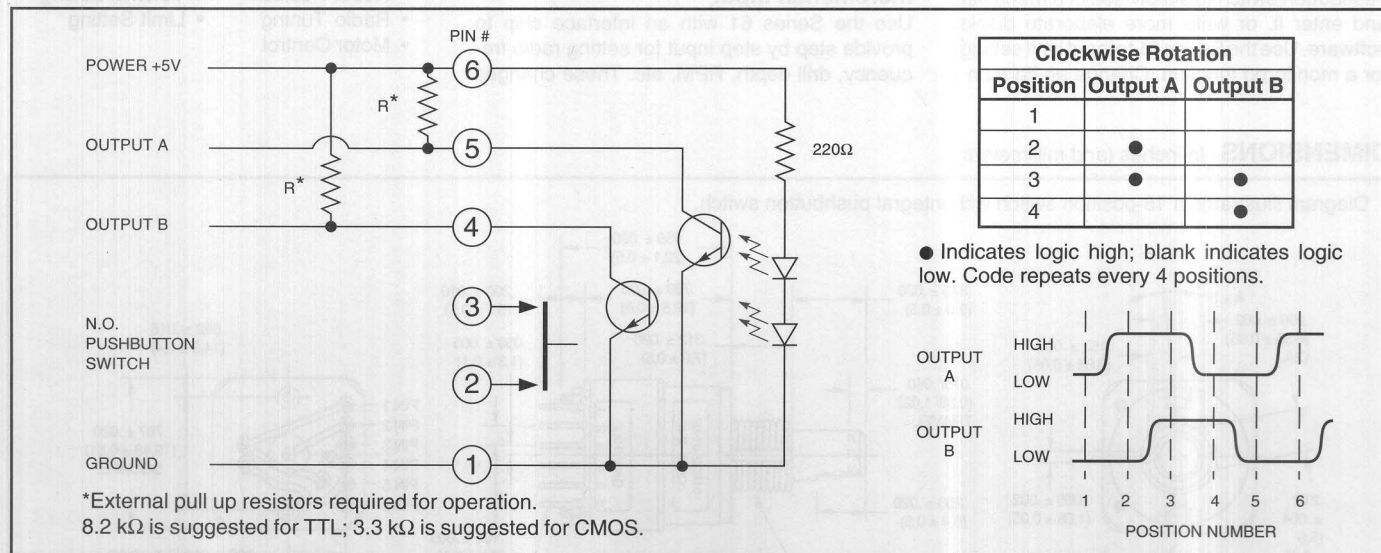
Mounting Hardware: One brass, Cadmium plated nut and lockwasher supplied with each switch. Nut is 0.094" thick by 0.562" across flats

Aperture: Brass, black oxide finish

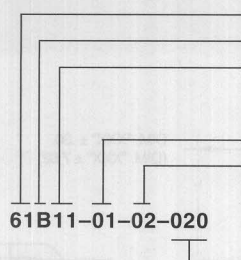
Strain Relief: PBT polyester thermoplastic (cable version only)

Cable: 26 AWG, stranded/tinned wire, PVC coated on .100 (2,54) centers (cable version only)

CIRCUITRY, TRUTH TABLE, AND WAVEFORM—Standard Quadrature 2-Bit Code



ORDERING INFORMATION



Series

Style: B = Standard, unsealed

Angle of Throw: 11 = 11.25° or 32 Positions

15 = 15° or 24 Positions

22 = 22.25° or 16 Positions

Coding: 01 = Quadrature

Pushbutton Option: 01 = Without pushbutton, 02 = With pushbutton

Termination: Blank (no dash or numbers) = pins as described in drawing
Cable Termination 020 = 2.0 inches minimum to 250 = 25 inches maximum
Provided in increments of 1/2 inch. Example 035 = 3.5", 060 = 6 inches. Cable is terminated with standard Amp Connector 640442-6. Use any 6 position .100 center header to mate with the cable assembly. Contact Grayhill for Series 61B without a detent.

ACCESSORIES

See page E-14.

OPTIONS

Not available thru Distributors

Different shaft and bushing lengths, shaft/panel seal, and additional supply voltages are possible.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

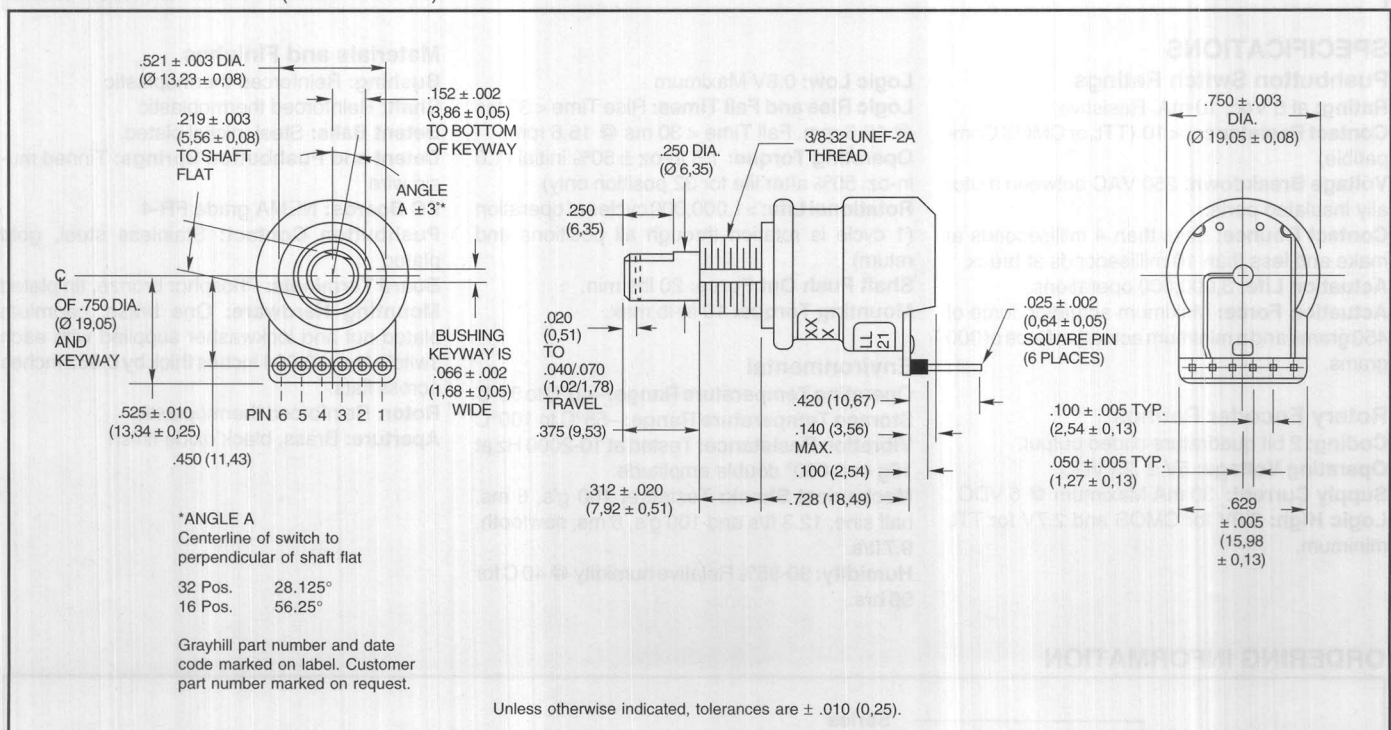
SERIES 61C 16 or 32 Position With integral Pushbutton

FEATURES

- Competitively Priced to Similar Electromechanical Switches
- Optically Coupled For More Than A Million Trouble-Free Rotations
- Has Data Entry Pushbutton Switch Activated By Switch Shaft
- Compatible With CMOS, TTL, and HCMOS Logic
- Operationally Used to Move Display Icon and Input Data
- Used to Set Radio Frequency, Drill Depth, RPM Etc.

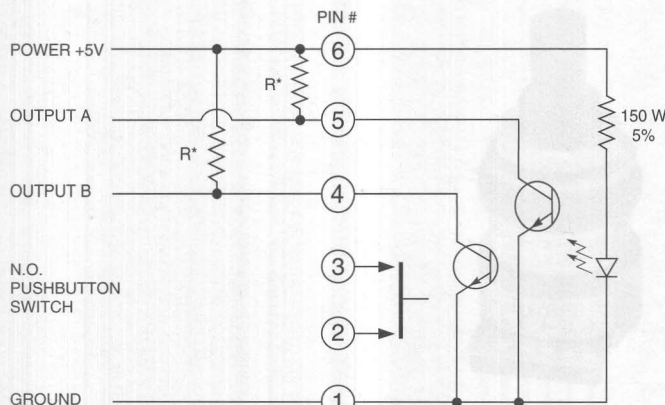


DIMENSIONS In inches (and millimeters)



OPTICAL ENCODERS

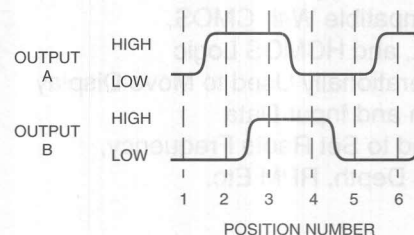
CIRCUITRY, TRUTH TABLE, AND WAVEFORM—Standard Quadrature 2-Bit Code



* External pull-up resistors required for operation.
8.2 k Ω is suggested for TTL; 3.3 k Ω is suggested for CMOS.

Clockwise Rotation		
Position	Output A	Output B
1		
2	●	
3	●	●
4		●

● Indicates logic high; blank indicates logic low. Code repeats every 4 positions.



SPECIFICATIONS

Pushbutton Switch Ratings

Rating: at 5 Vdc, 10 mA, Resistive

Contact Resistance: < 10 (TTL or CMOS Compatible)

Voltage Breakdown: 250 VAC between mutually insulated parts.

Contact Bounce: Less than 4 milliseconds at make and less than 10 milliseconds at break.

Actuation Life: 3,000,000 operations.

Actuation Force: Maximum actuation force of 450 grams and a minimum actuation force of 300 grams.

Rotary Encoder Ratings

Coding: 2 bit quadrature coded output.

Operating Voltage: 5V \pm .25 VDC

Supply Current: 30 mA Maximum @ 5 VDC

Logic High: 3.8V for CMOS and 2.7V for TTL minimum.

Logic Low: 0.8V Maximum

Logic Rise and Fall Times: Rise Time < 30 ms @ 16.6 rpm. Fall Time < 30 ms @ 16.6 rpm.

Operating Torque: 1.5 in-oz \pm 50% initial (1.0 in-oz 50% after life for 32 position only)

Rotational Life: > 1,000,000 cycles of operation (1 cycle is rotation through all positions and return)

Shaft Push Out Force: 20 lbs min.

Mounting Torque: 10 in-lb max.

Environmental

Operating Temperature Range: -40°C to 85°C

Storage Temperature Range: -55°C to 100°C

Vibration Resistance: Tested at 10-2000 Hz at 15g or 0.060" double amplitude.

Mechanical Shock: Tested at 100 g's, 6 ms, half sine, 12.3 ft/s and 100 g's, 6 ms, sawtooth, 9.7 ft/s.

Humidity: 90-95% Relative humidity @ 40°C for 96 hrs.

Materials and Finishes

Bushing: Reinforced thermoplastic

Shaft: Reinforced thermoplastic

Detent Balls: Steel, nickel plated

Detent and Pushbutton Springs: Tinned music wire

PC Boards: NEMA grade FR-4

Pushbutton Contact: Stainless steel, gold plated

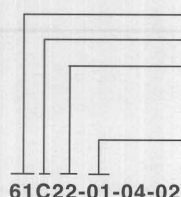
Board Terminals: Phosphor bronze, tin plated

Mounting Hardware: One brass, cadmium plated nut and lockwasher supplied with each switch. Nut is 0.094 inches thick by 0.562 inches across flats.

Rotor: Reinforced thermoplastic

Aperture: Brass, black oxide finish

ORDERING INFORMATION



Series

Style: C = Standard

Angle of Throw: 00 = No detent

11 = 11.25° or 32 Positions

22 = 22.25° or 16 Positions

Coding: 01 = Quadrature

Pushbutton Option: 01 = Without pushbutton, 02 = With pushbutton

Number of Changes per Revolution: 04, 08

61C22-01-04-02

ACCESSORIES

See page E-14.

These switches have Quadrature 2-Bit Code output and a shaft actuated pushbutton switch.

Available from your local Grayhill Distributor.

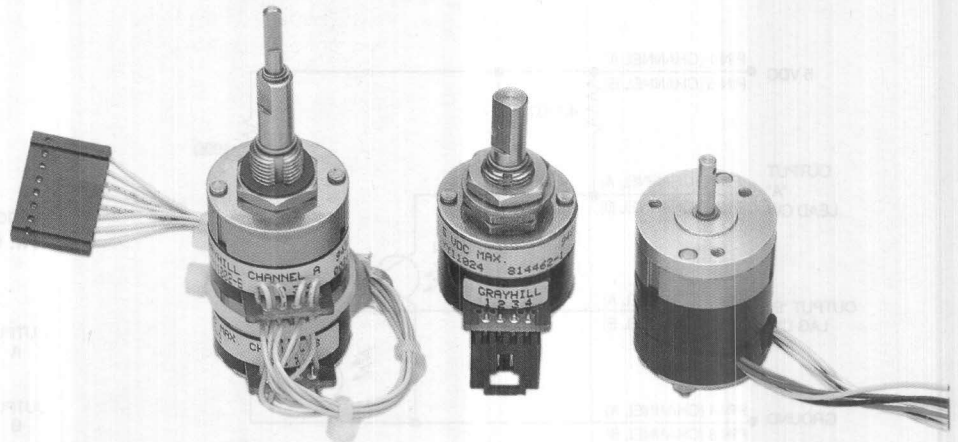
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 61D

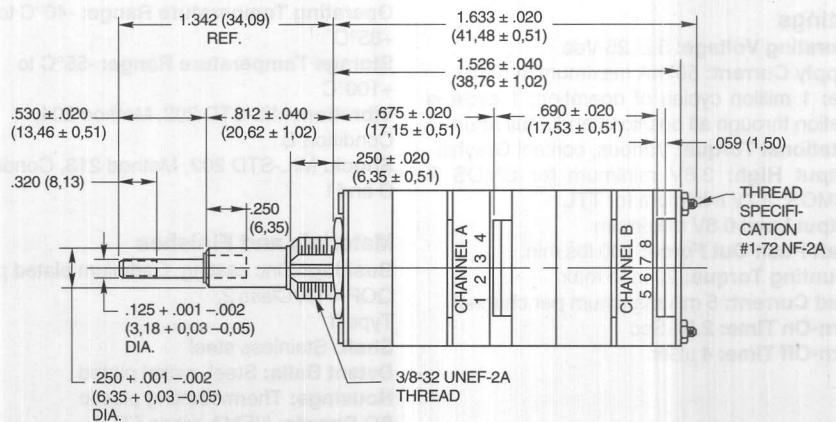
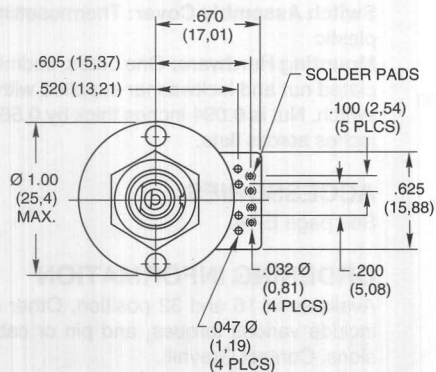
Industrial Concentric Shaft

FEATURES

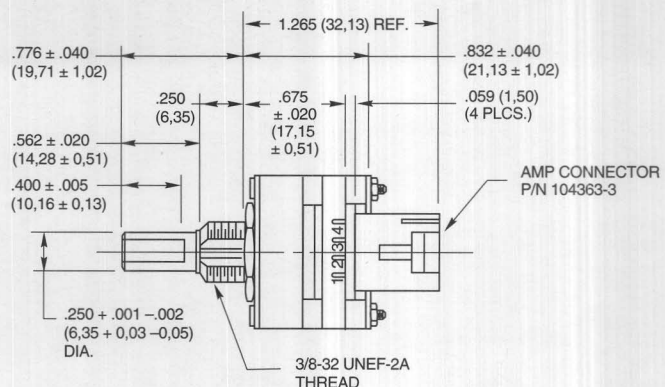
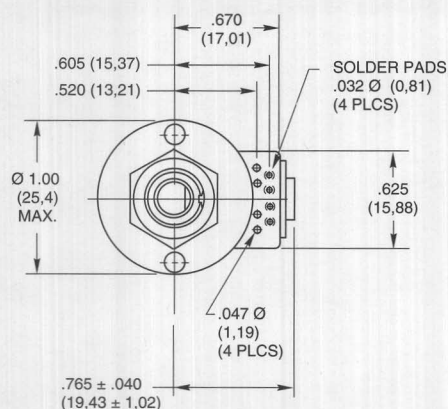
- Concentric Shaft
- Saves Space on Crowded Instrument Panels
- Designed for Operator Input of Distinct Parameters
- One Code Change per Detent Position
- Extended Temperature
- Stainless Steel Shaft and Metal Bushing



DIMENSIONS In inches (and millimeters)

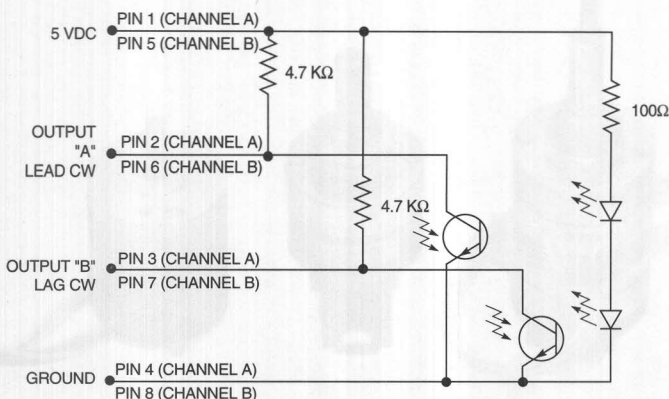


Grayhill part number and date code marked on label. Customer part number marked on request.



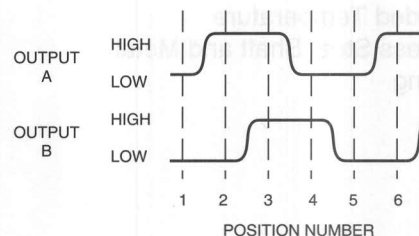
OPTICAL ENCODERS

CIRCUITRY, TRUTH TABLE, AND WAVEFORM—Standard Quadrature 2-Bit Code



Clockwise Rotation		
Position	Output A	Output B
1		
2	●	
3	●	●
4		●

● Indicates logic high; blank indicates logic low. Code repeats every 4 positions.



SPECIFICATIONS

Ratings

Operating Voltage: $5 \pm .25$ Vdc

Supply Current: 50 mA maximum at 5 Vdc

Life: 1 million cycles of operation; 1 cycle is rotation through all positions and a full return

Rotational Torque: Various, contact Grayhill

Output High: 3.8V minimum for CMOS & HCMOS; 2.7V minimum for TTL

Output Low: 0.8V maximum

Shaft Push Out Force: 100 lbs min.

Mounting Torque: 20 in-lb max.

Load Current: 5 mA maximum per channel

Turn-On Time: 2.5 μ Sec

Turn-Off Time: 4 μ Sec

Environmental

Operating Temperature Range: -40°C to +85°C

Storage Temperature Range: -55°C to +100°C

Vibration: MIL-STD 202, Method 204, Condition B

Shock: MIL-STD 202, Method 213, Condition C and I

Materials and Finishes

Bushing: Zinc casting, Cadmium plated per QQP-416, Class 2, Type II

Shaft: Stainless steel

Detent Balls: Steel, nickel plated

Housings: Thermosetting plastic

PC Boards: NEMA grade FR-4

Board Terminals: Copper alloy, CDA No. 725, solder coated

Through Bolts: Stainless steel, unplated

Through Bolt Nuts: Stainless steel

Switch Assembly Cover: Thermosetting plastic

Mounting Hardware: One brass, cadmium plated nut and lockwasher supplied with each switch. Nut is 0.094 inches thick by 0.562 inches across flats.

ACCESSORIES

See page E-14.

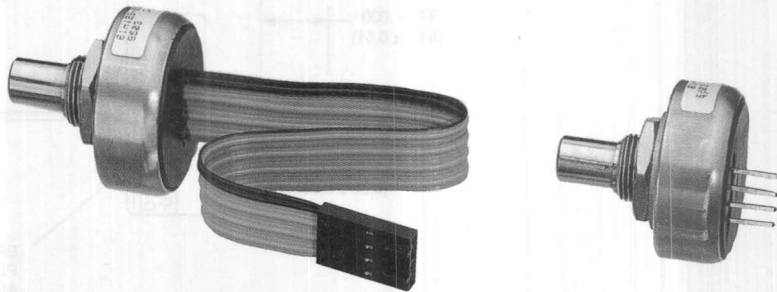
ORDERING INFORMATION

Available in 16 and 32 position. Other options include various torques, and pin or cable versions. Contact Grayhill.

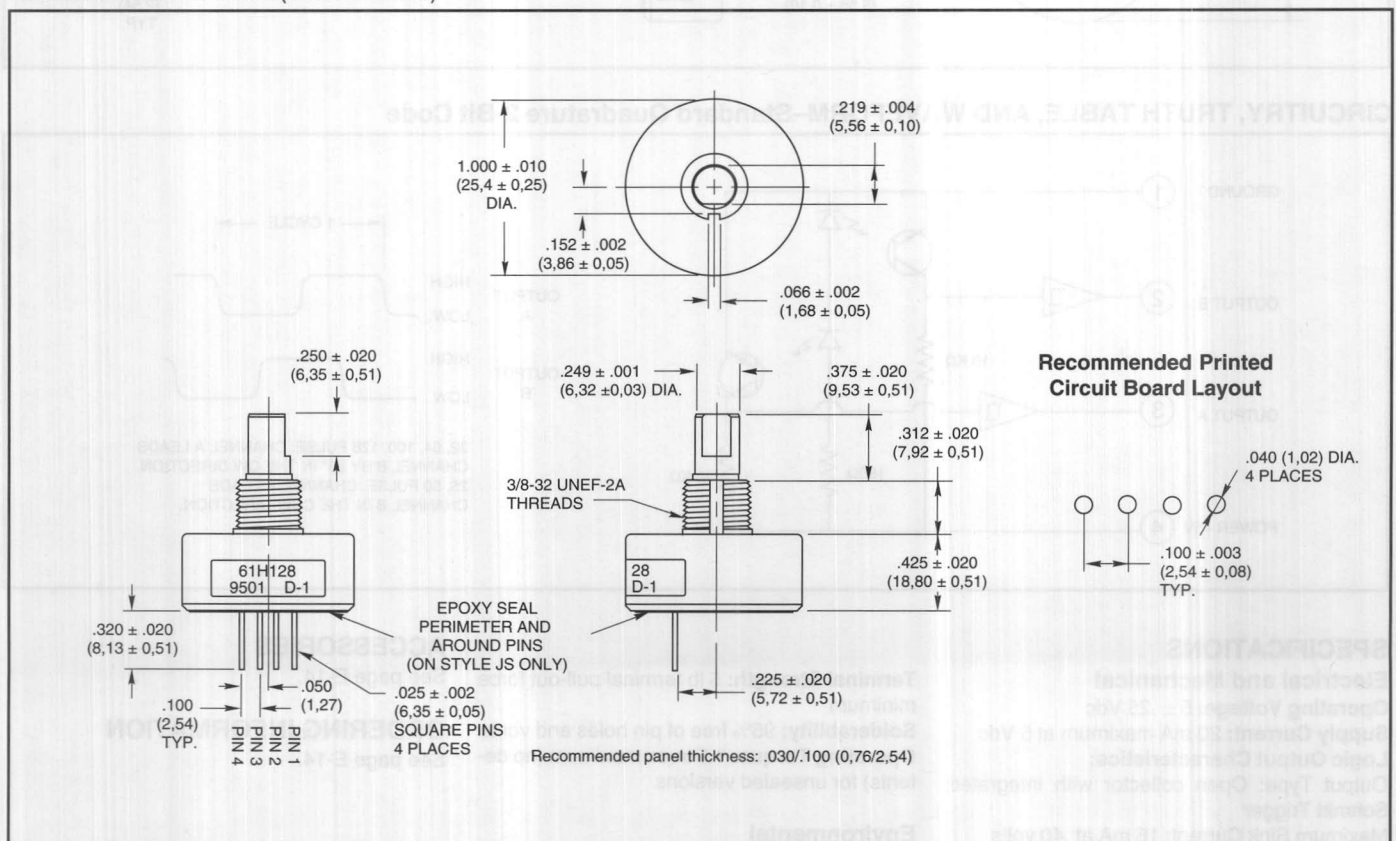
SERIES 61H High Resolution, 4 Pin

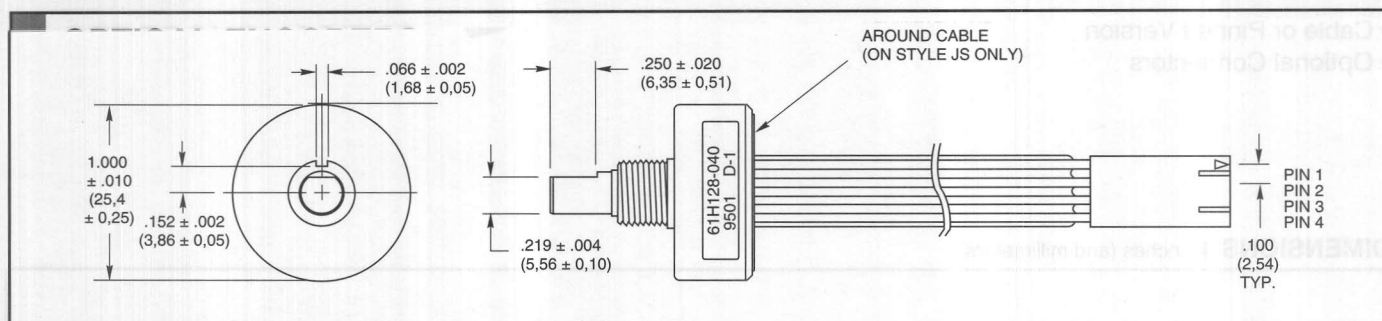
FEATURES

- High Resolution
- 25, 32, 50, 64, 100 and 128 Cycles per Revolution Available
- Compact Size
- Optional Panel and/or Shaft Seal
- Rugged Construction
- Optional Bearing for High Speed Output
- Cable or Pinned Version
- Optional Connectors

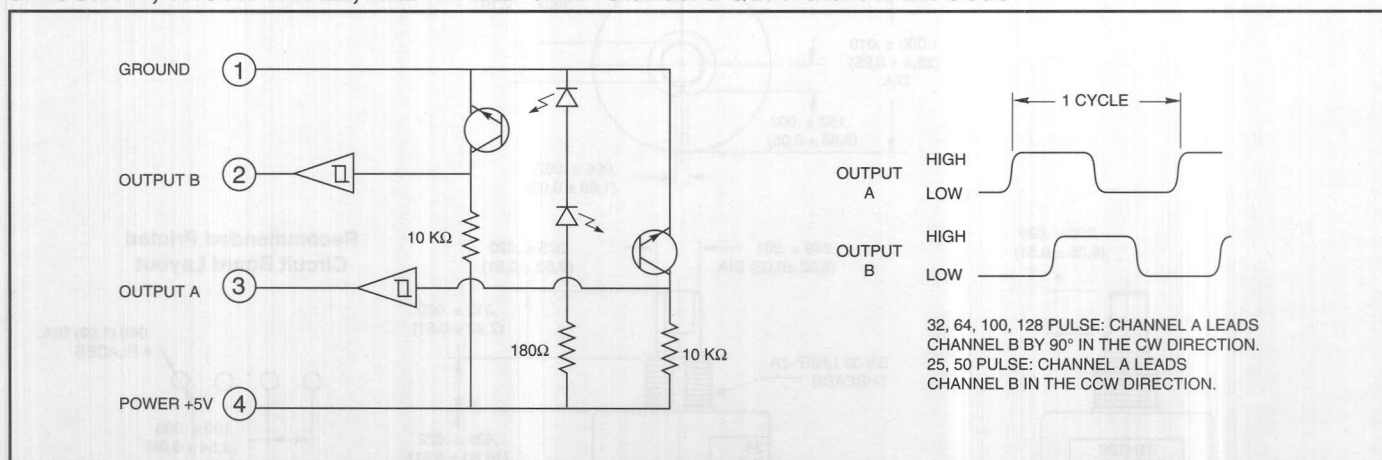


DIMENSIONS In inches (and millimeters)





CIRCUITRY, TRUTH TABLE, AND WAVEFORM—Standard Quadrature 2-Bit Code



SPECIFICATIONS

Electrical and Mechanical

Operating Voltage: 5 \pm .25 Vdc

Supply Current: 20 mA maximum at 5 Vdc

Logic Output Characteristics:

Output Type: Open collector with integrated Schmitt Trigger

Maximum Sink Current: 16 mA at .40 volts

Power Consumption: 150 mW maximum

Output: Preconditioned Schmitt Trigger photo IC

Optical Rise Time: 500 ns typical

Optical Fall Time: 14 ns typical

Mechanical Life: 5 million revolutions

Time Life: Guaranteed for 10 years of continuous operation (calculated from emitter degradation data)

Mounting Torque: 20 in-lb maximum

Shaft Push Out Force: 100 lb minimum

Terminal Strength: 5 lb terminal pull-out force minimum

Solderability: 95% free of pin holes and voids

Operating Torque: 1.5 in-oz maximum (no dents) for unsealed versions

Environmental

Operating Temperature Range: -40°C to 85°C

Storage Temperature Range: -55°C to 100°C

Humidity: 96 hours at 90-95% humidity at 40°C

Mechanical Vibration: Harmonic motion with amplitude of 15g, within a varied 10 to 20 Hz frequency for 12 hours

Mechanical Shock: Test 1: 100g for 6 ms Half-sine wave with velocity change of 12.3 ft/s. Test 2: 100g for 6 ms Sawtooth wave with velocity change of 9.7 ft/s

ACCESSORIES

See page E-14.

ORDERING INFORMATION

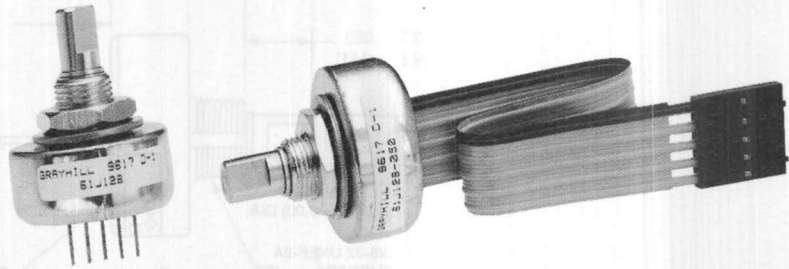
See page E-14.

SERIES 61J

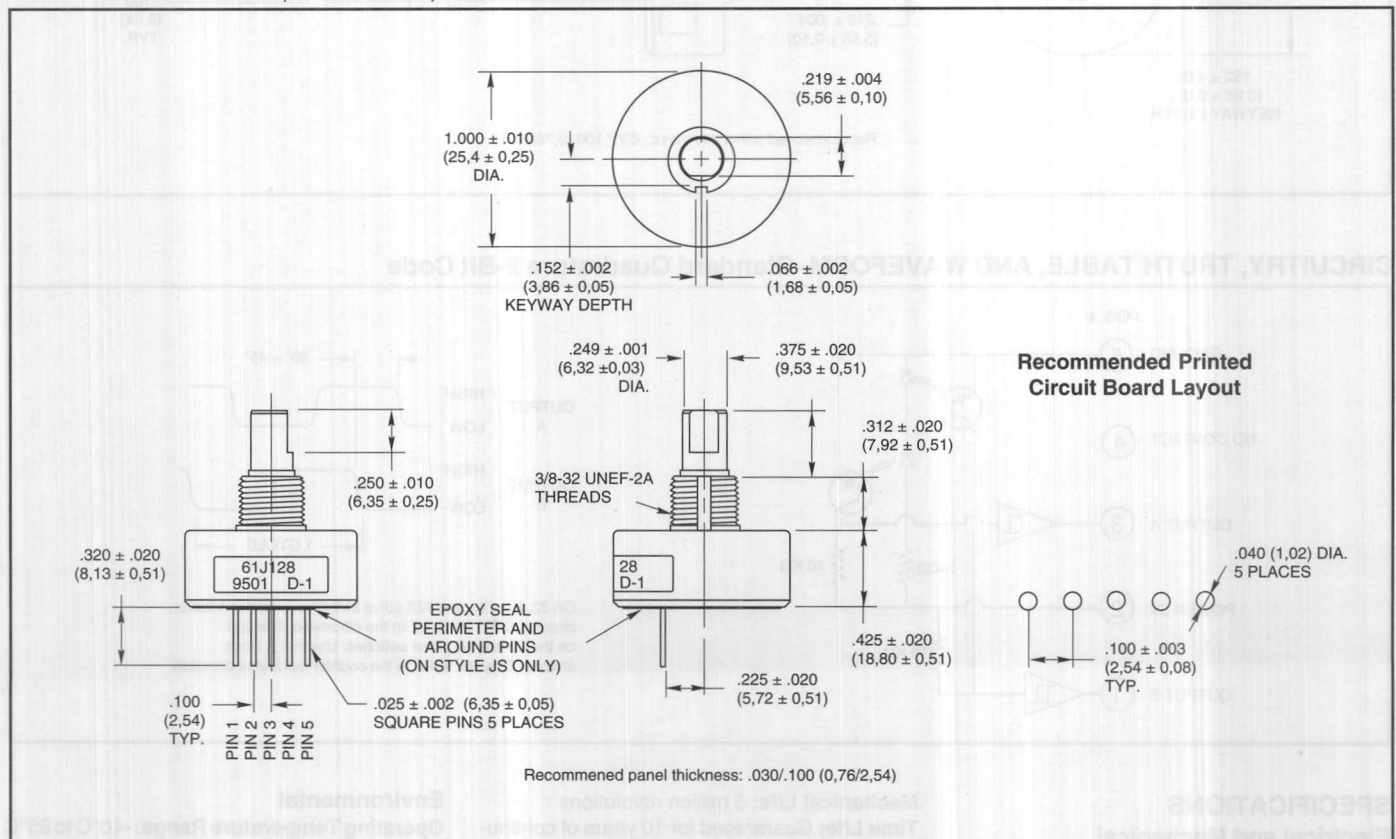
High Resolution, 5 Pin
(Polarized Connection)

FEATURES

- High Resolution
- 25, 32, 50, 64, 100 and 128 Cycles per Revolution Available
- Compact Size
- Optional Panel and/or Shaft Seal
- Rugged Construction
- Optional Bearing for High Speed Output
- Cable or Pinned Version
- Optional Connectors

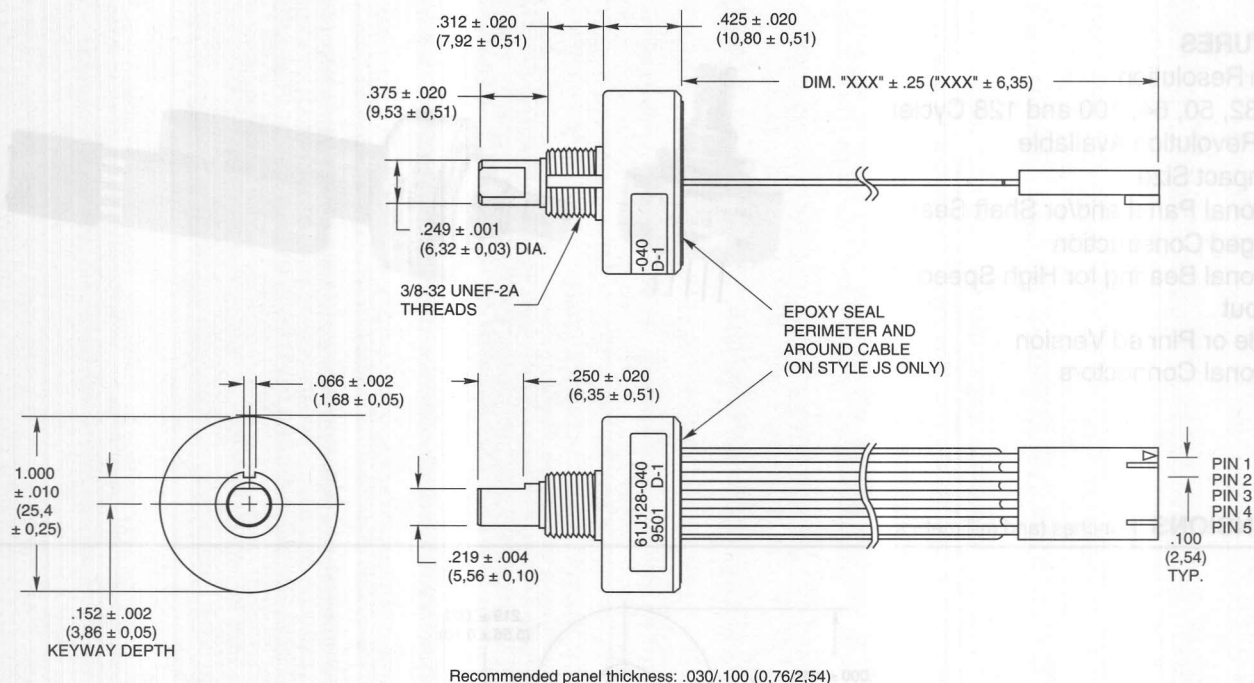


DIMENSIONS In inches (and millimeters)

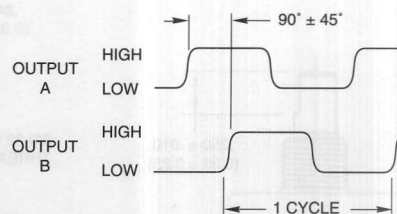
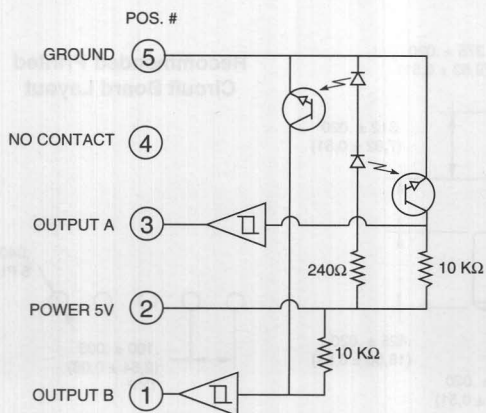


OPTICAL ENCODERS

DIMENSIONS In inches (and millimeters)



CIRCUITRY, TRUTH TABLE, AND WAVEFORM—Standard Quadrature 2-Bit Code



On 32, 64, 100 and 128 pulse switches: channel A leads channel B BY $90^\circ \pm 45^\circ$ in the clockwise direction.
on the 25 and 50 pulse switches: channel A leads channel B by $90^\circ \pm 45^\circ$ in the counter clockwise direction.

SPECIFICATIONS

Electrical and Mechanical

Operating Voltage: $5 \pm .25$ Vdc

Supply Current: 20 mA maximum at 5 Vdc

Logic Output Characteristics:

Output Type: Open collector with integrated Schmitt Trigger

Maximum Sink Current: 16 mA at .40 volts

Power Consumption: 150 mW maximum

Output: Preconditioned Schmitt Trigger photo IC

Optical Rise Time: 500 ns typical

Optical Fall Time: 14 ns typical

Mechanical Life: 5 million revolutions

Time Life: Guaranteed for 10 years of continuous operation (calculated from emitter degradation data)

Mounting Torque: 20 in-lb maximum

Shaft Push Out Force: 100 lb minimum

Terminal Strength: 5 lb terminal pull-out force minimum

Solderability: 95% free of pin holes and voids

Operating Torque: 1.5 in-oz maximum (no dents) for unsealed versions

Environmental

Operating Temperature Range: -40°C to 85°C

Storage Temperature Range: -55°C to 100°C

Humidity: 96 hours at 90-95% humidity at 40°C

Mechanical Vibration: Harmonic motion with amplitude of 15g, within a varied 10 to 20 Hz frequency for 12 hours

Mechanical Shock: Test 1: 100g for 6 ms Half-sine wave with velocity change of 12.3 ft/s. Test 2: 100g for 6 ms Sawtooth wave with velocity change of 9.7 ft/s

Materials

Housing: Cast zinc with zinc plating and clear chromate

Shaft: Stainless steel

Code Rotor and Aperture: Chemically etched stainless steel

Printed Circuit Board: NEMA Grade FR-4. 6-

8 μ " gold over 75 μ " min. nickel over copper

Optical Barrier and Back Plate: Polyphenylene sulfide, 94 V-0

Header: Phosphor bronze, 200 μ " Sn over 50 μ " Ni (pinned versions only)

Infrared Emitter: Gallium aluminum arsenide

Photo IC: Planar silicon

Retaining Ring: Stainless steel

Cable: 26 AWG, stranded/tinned wire, PVC coated on .100 (2,54) centers (cable version only)

ORDERING INFORMATION



Series

Style: H = Standard, 4 pin, high resolution

HS = Sealed, 4 pin, high resolution

J = Standard, 5 pin, high resolution

JS = Sealed, 5 pin, high resolution

Cycles: per channel per revolution = 25, 32, 50, 64, 100, 128

Termination: Blank (no dash or numbers) = pins as described in drawing

Cable Termination 020 = 2.0 inches min. to 250 = 25 inches max.

Provided in increments of 1/2 inch. Example 035 = 3.5", 060 = 6". Cable is

terminated with standard Molex part no. 14-56-3046 for 61H, 14-56-3056 for 61J.

Use any standard .100 center 4 pin header for 61H, 5 pin header for 61J to

interface with cable. Recommended to be mounted with Molex header part no.

70543-0003 or 70553-0003 for 61H, 70543-0004 or 70553-0004 for 61J.

These switches have Quadrature 2-Bit Code output.

ACCESSORIES

See below.

Available from your local Grayhill Distributor.

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ACCESSORIES

Non-Turn Washer

The Series 61 bushing is 3/8 inches in diameter and has a non-turn keyway to prevent rotation of the switch body when the panel is cut to fit.

Another way to keep the switch from turning is to use a non-turn washer. The washer is cadmium plated brass.

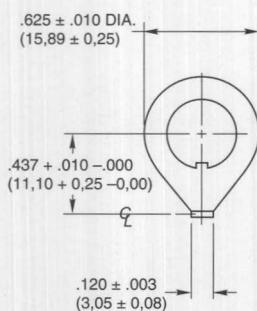
Part number: **12C1087-1**

Part number: **SHH694-11**

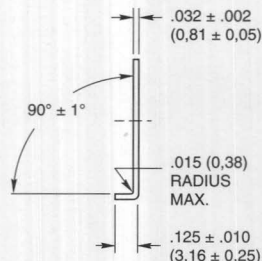
Shaft and Panel Seal

For shaft and panel seal version, the shaft is sealed by an O-ring inside the bushing. The panel is sealed by a flat gasket .045" thick at the base of the bushing. The panel seals will increase the behind panel dimension by .020" to .040", when the switch is mounted. The panel seal is silicon rubber. The shaft seal is an O-ring per MIL-P-5516B.

DIMENSIONS In inches (and millimeters)



Part Number: **12C1087-1**



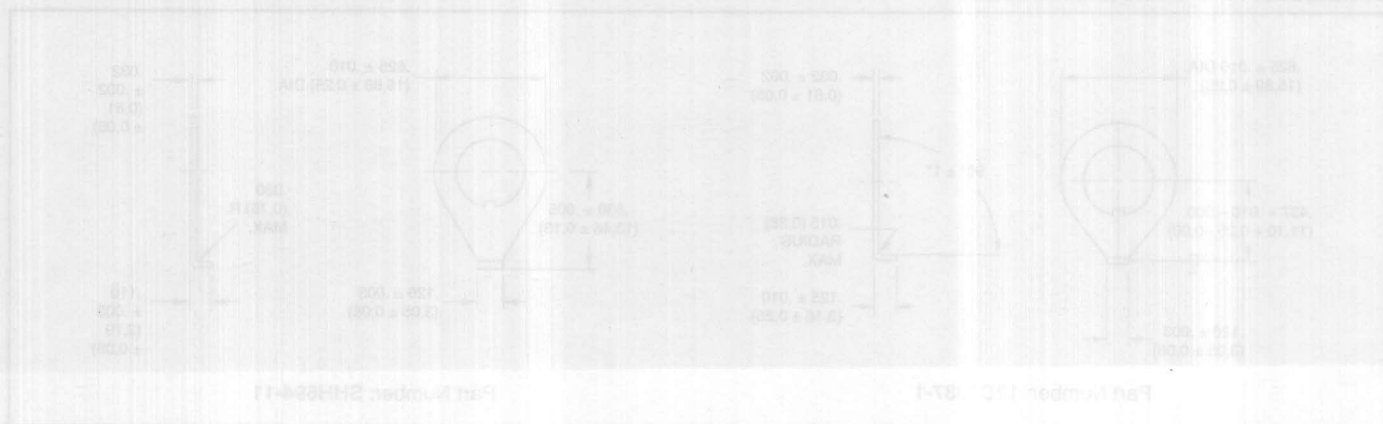
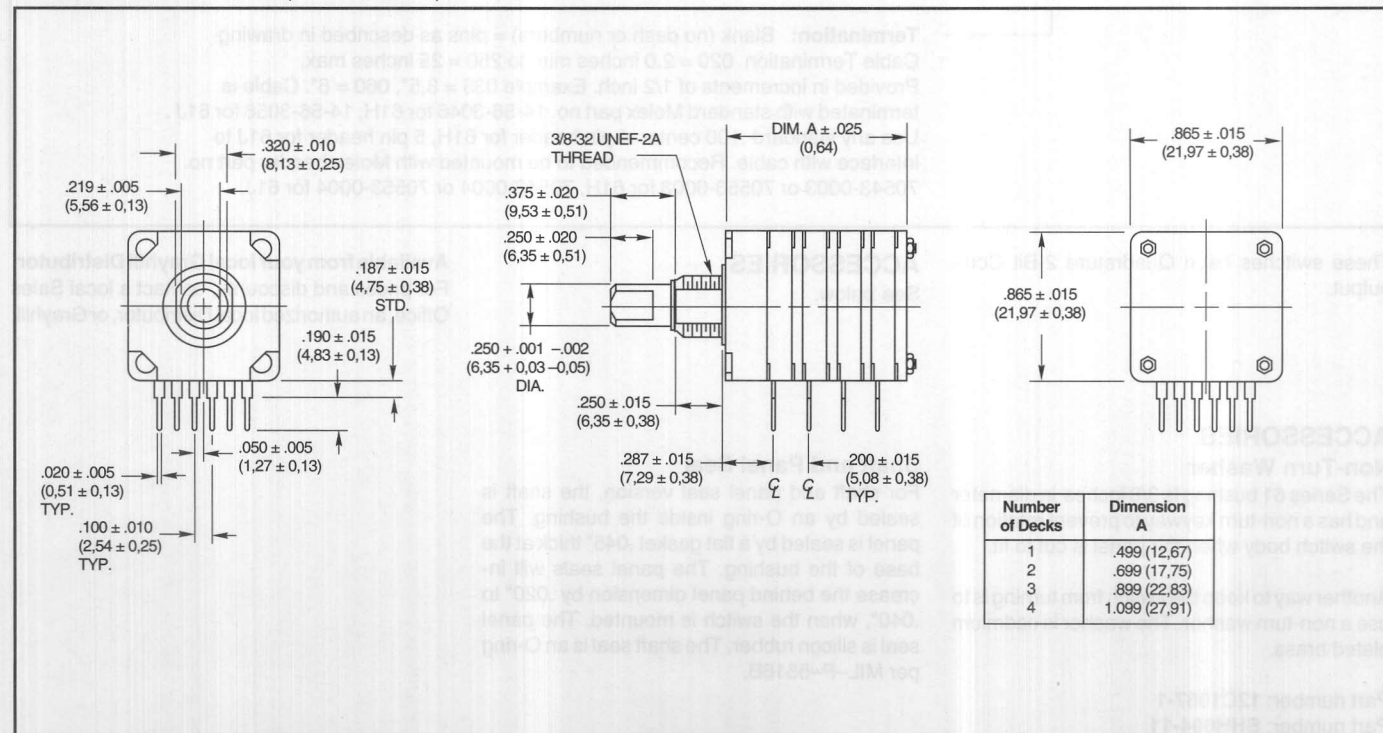
Part Number: **SHH694-11**

Panel Seal Option

- Manufactured to ISO-9001 and Military Standards



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Electrical Ratings

Switching Loads: 150 mA @ 120 Vac, resistive; 150 mA @ 28 Vdc, resistive

Current Carrying Capacity: 250 mA @ 28 Vdc, resistive

Contact Resistance: 75 mΩ max. after life

Insulation Resistance: 1000 mΩ min. between terminals and shaft

Voltage Breakdown: 1000 Vac min. between terminals and shaft

Life Expectancy: 50,000 cycles @ rated loads

Contacts: Shorting

Mechanical

Stop Strength: 15 in-lbs min.

Rotational Torque: 4–20 in-oz, dependent on the number of decks

Operating Temperature: -65°C to +85°C

Non-Turn Device: Flatted mounting bushing, .375" dia. x .320" double "D" across flats

Package Size: .865" square

Termination: PC terminals, .100" on center. Decks are .200" apart.

Materials and Finishes

Bushing: Die cast zinc alloy, zinc plated and chromate treated

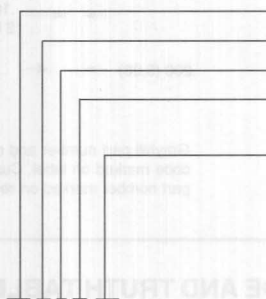
Shaft, Stop Blades, Detent Balls, Throughbolts, Nuts: Stainless steel

Mounting Hardware: Plated brass

Decks, Deck Separators, End Plate: Thermoplastic

Contacts and Terminals: Beryllium copper, gold plated

ORDERING INFORMATION



25BSP10-B-2-36C

Series number

Shaft size: B = 1/4" diameter shaft

Sealed or Non-Sealed: S = Shaft and panel seal; No letter = no seal

Terminal structure: P = PC, perpendicular to shaft; R = PC, rear facing (one deck only); F = PC, front facing (one deck only).

Angle of throw (determines the maximum number of positions):

10 = 10°, 36 positions; 11 = 11.25°, 32 positions; 12 = 12°, 30 positions;

15 = 15°, 24 positions; 18 = 18°, 20 positions; 22 = 22.5°, 16 positions;

30 = 30°, 12 positions; 36 = 36°, 10 positions; 45 = 45°, 8 positions;

60 = 60°, 6 positions; 90 = 90°, 4 positions.

Stop Arrangement: For switches with maximum positions, add C for continuous rotation; add F for stop between first and last. No notation required for less than maximum positions.

Number of positions: Maximum is dependent on the angle of throw. Minimum is two.

Number of decks: One through four possible.

Code output:

B = Binary; C = Binary Complement; Q = Quadrature; G = Gray

Specials include 1/8" diameter shaft

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MECHANICAL ENCODERS

BINARY CODED

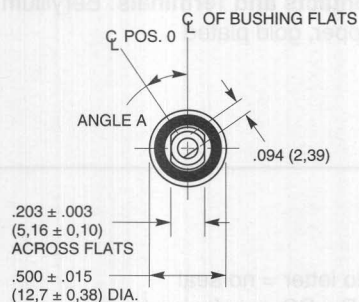
SERIES 26

AVAILABLE CODES

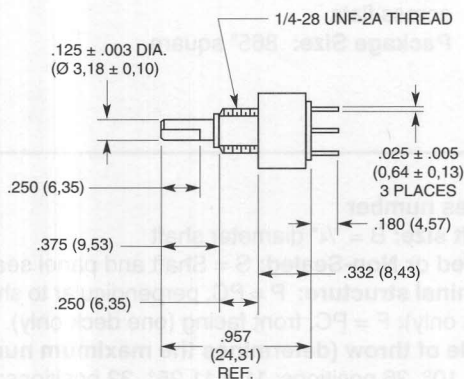
- Hexadecimal
- Octal
- BCD (Adjusted)
- Gray



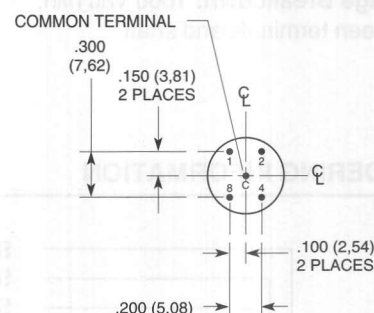
DIMENSIONS In inches (and millimeters)



Maximum Switch Positions	Angle A
8	67.5°
16	33.75°



Unless specified otherwise, all tolerances are $\pm .015$ (0,38)



Grayhill part number and date code marked on label. Customer part number marked on request.

SPECIFICATIONS

Ratings

Electrical Rating: 25,000 cycles with logic compatible loads. Make and break 200 mA.

Contact Resistance: 500 milliohms maximum (less than 100 milliohms initially)

Insulation Resistance: 1000 megohms minimum (10,000 megohms initially)

Dielectric Strength: 250 Vac minimum

Materials and Finishes

Panel Seal: Silicone Rubber

Shaft Seal: Fluorosilicone

Mounting Nut (mounting hardware—one per switch): Brass, cadmium plated

Internal Tooth Lockwasher (mounting hardware—one per switch): Steel, cadmium plated

Detent Balls: Carbon steel, nickel plated

Detent Spring: Pretinned music wire

Detent Rotor: Thermoplastic

Shaft, Stop Arm and Stop Pins: Stainless steel

Bushing: Zamak II tin/zinc alloy, zinc plated

Switch Base: Diallyl phthalate

PC Board: FR-4

Terminals: Brass, gold plated nickel plate

Contacts: Copper alloy, gold plated over nickel plate

Additional Characteristics

Rotational Torque: 4 to 8 ounce-inches on a new switch.

Vibrations: 10 to 55 Hz at 0.060" double amplitude; no damage and no contact openings per MIL STD 202, Method 201A

Mechanical Shock: Passes medium requirement MIL-S-3785 (MIL-STD-202, Method 213)

Stop Strength: 5 inch-pounds minimum

Humidity: Passes tests at 90 to 95% humidity, 40°C for 240 hours (MIL STD 202 Method 103, Test Contition A)

Terminals: All switches are provided with all 5 terminals, regardless of the number of active positions.

ADJUSTABLE STOPS

The switch may have continuous rotation, or be adjusted to limit the rotation. The panel seal ring can be removed to expose the stop pin holes on the front of the switch.

Two stop pins and panel seal O-ring are supplied with the switch. One or both may be used to limit the rotation as desired.

SHAFT AND PANEL SEAL

All switches are provided with a shaft and panel seal.

ORDERING INFORMATION

BCD Output—Adjustable Stop

Number of Positions	Part Number
8 Positions	26ASD45-01-1-AJS
16 Positions	26ASD22-01-1-AJS

Gray Code Output—Continuous Rotation**

Number of Positions	Part Number
16 Positions	26GS22-01-1-16S-C

All switches have shorting contacts.

** Contact Grayhill for availability of Series 26 Gray Code Output switches with adjustable stops.

CODE AND TRUTH TABLE

Switch Position	Code Position	BCD Output*				Gray Output*			
		1	2	4	8	1	2	4	8
1	0								
2	1	•				•			
3	2		•			•	•		
4	3	•	•				•		
5	4			•			•	•	
6	5	•		•		•	•	•	
7	6		•	•		•		•	
8	7	•	•	•				•	
9	8				•			•	•
10	9	•			•			•	•
11	10		•		•	•	•	•	•
12	11	•	•		•		•	•	•
13	12			•	•		•		•
14	13	•		•	•	•	•		•
15	14		•	•	•	•			•
16	15	•	•	•	•				•

*Dot indicates terminal tied to common.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

BCD OR BCD COMPLEMENT BINARY CODED

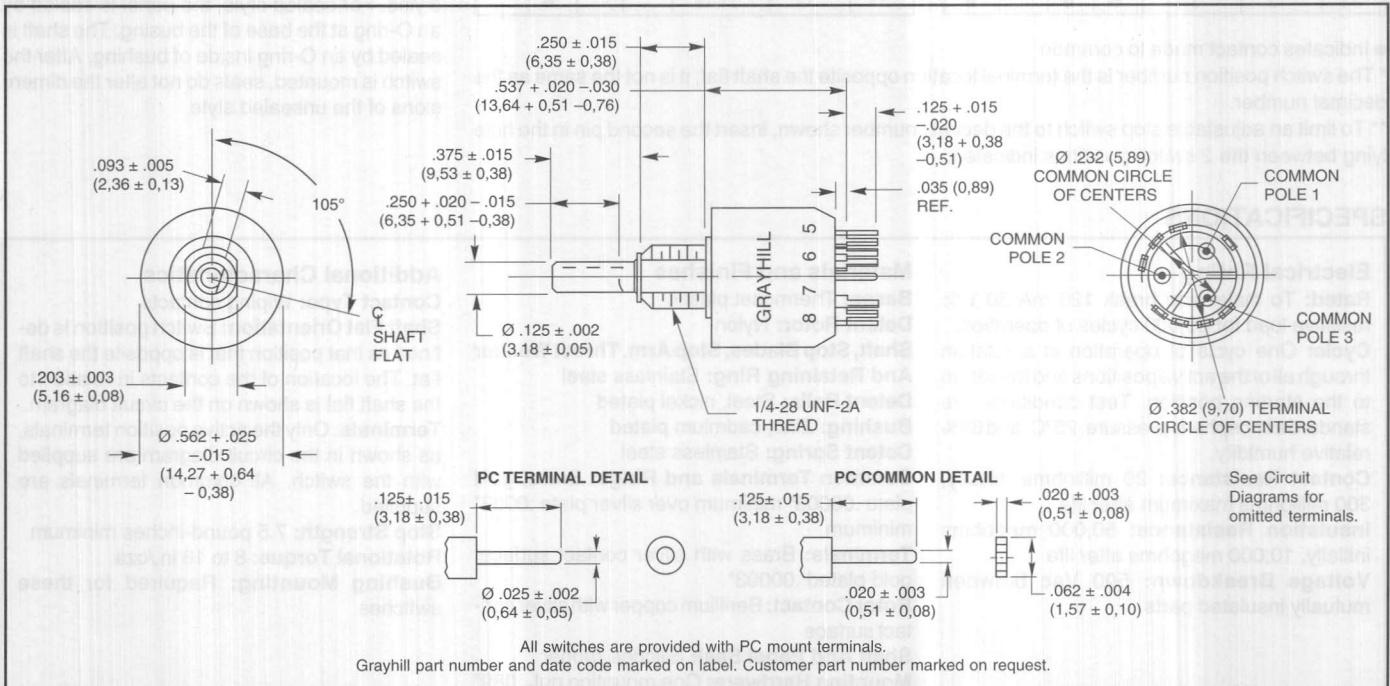
SERIES 51

FEATURES

- Choice of Binary Code Decimal Or BCD Complement
- PC Mount, 30° Angle of Throw In 2 to 12 positions
- 1/2" Diameter, 200 mA
- Shaft and Panel Seal Plus Adjustable Stop Versions



DIMENSIONS In Inches (and millimeters)



CIRCUIT DIAGRAMS

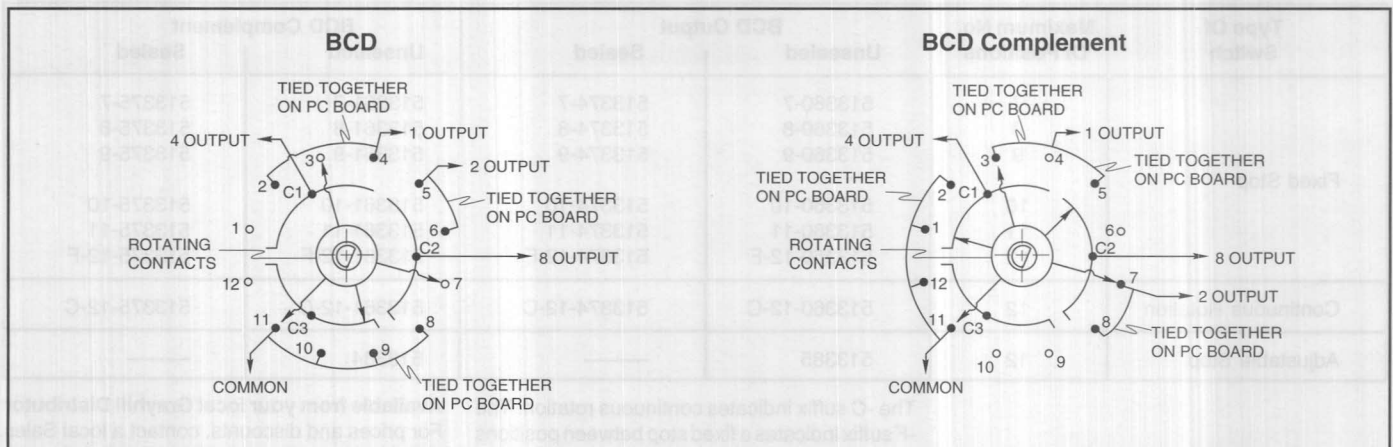
Switch is viewed from the shaft end and shown in switch position number 1, which is decimal number zero and BCD number zero.

- Indicates Terminal is present.
- Indicates Terminal is omitted.

Note: Connections must be made on PC board to

generate code output.

Switch position numbers do not correspond to the decimal input or binary output. See Truth Tables.



TRUTH TABLES

Binary Code Decimal

Dec. No.	Switch Pos'n.*	2nd Pin**	Output 1	Output 2	Terminal 4	Terminal 8
0	1	4-5				
1	2	5-6	●			
2	3	6-7		●		
3	4	7-8	●	●		
4	5	8-9			●	
5	6	9-10	●		●	
6	7	10-11		●	●	
7	8	11-12	●	●	●	
8	9	12-1				●
9	10	1-2	●			●
10	11	2-3		●		●
11	12	3-4	●	●		●

● Indicates contact made to common

* The switch position number is the terminal location opposite the shaft flat; it is not the same as the decimal number.

** To limit an adjustable stop switch to the decimal number shown, insert the second pin in the hole lying between the 2 switch positions indicated.

Binary Code Decimal Complement

Dec. No.	Switch Pos'n.*	2nd Pin**	Output 1	Output 2	Terminal 4	Terminal 8
0	1	12-1	●	●	●	●
1	2	1-2		●	●	●
2	3	2-3	●		●	●
3	4	3-4			●	●
4	5	4-5	●	●		●
5	6	5-6		●		●
6	7	6-7	●			●
7	8	7-8				●
8	9	8-9	●	●	●	
9	10	9-10		●	●	
10	11	10-11	●		●	
11	12	11-12			●	

ADJUSTABLE STOPS

Set and reset stops to limit rotation. All dimensions are the same as for fixed stop switches. Switches are shipped with the stop blades located to limit rotation to 11 switch positions. For continuous rotation, remove both blades. For limited rotation, remove the 2nd (clockwise) blade and move it to the hole located between the positions shown in the Truth Tables. Removal of a plastic washer provides access to the blades and slots. Adjustable stop versions are available in unsealed styles only.

SHAFT AND PANEL SEAL

Switches are available in sealed or unsealed styles. For sealed style, the panel is sealed by an O-ring at the base of the busing. The shaft is sealed by an O-ring inside of bushing. After the switch is mounted, seals do not alter the dimensions of the unsealed style.

SPECIFICATIONS

Electrical Rating

Rated: To make and break 125 mA 30 Vdc resistive load for 25,000 cycles of operation.

Cycle: One cycle of operation is a rotation through all of the active positions and the return to the starting position. Test conditions are standard atmospheric pressure, 25°C. and 68% relative humidity.

Contact Resistance: 20 milliohms initially, 300 milliohms maximum after life

Insulation Resistance: 50,000 megohms initially, 10,000 megohms after life

Voltage Breakdown: 500 Vac between mutually insulated parts

Materials and Finishes

Bases: Thermoset plastic

Detent Rotor: Nylon

Shaft, Stop Blades, Stop Arm, Thrust Washer

And Retaining Ring: Stainless steel

Detent Balls: Steel, nickel plated

Bushing: Zinc, cadmium plated

Detent Spring: Stainless steel

Common Terminals and Rings: Brass, gold plate .00003" minimum over silver plate .0003" minimum

Terminals: Brass with silver contact surface, gold plated .00003"

Rotor Contact: Berillium copper with silver contact surface

Shaft And Panel Seal: Silicone rubber

Mounting Hardware: One mounting nut, .089" thick by .375" across flats, and one internal tooth lockwasher are supplied with the switch.

Additional Characteristics

Contact Type: Wiping contacts

Shaft Flat Orientation: Switch position is defined as that position that is opposite the shaft flat. The location of the contacts in relation to the shaft flat is shown on the circuit diagram.

Terminals: Only the active position terminals, as shown in the circuit diagram are supplied with the switch. All common terminals are supplied.

Stop Strength: 7.5 pound-inches minimum

Rotational Torque: 8 to 16 in./ozs.

Bushing Mounting: Required for these switches

ORDERING INFORMATION

Type Of Switch	Maximum No. Of Positions	BCD Output		BCD Complement	
		Unsealed	Sealed	Unsealed	Sealed
Fixed Stop	7	513360-7	513374-7	513361-7	513375-7
	8	513360-8	513374-8	513361-8	513375-8
	9	513360-9	513374-9	513361-9	513375-9
	10	513360-10	513374-10	513361-10	513375-10
	11	513360-11	513374-11	513361-11	513375-11
	12	513360-12-F	513374-12-F	513361-12-F	513375-12-F
Continuous Rotation	12	513360-12-C	513374-12-C	513361-12-C	513375-12-C
Adjustable Stop	12	513385	—	513384	—

The -C suffix indicates continuous rotation. The -F suffix indicates a fixed stop between positions 1 and 12.

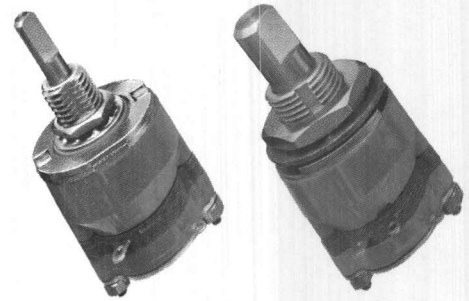
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

BCD, 1/4 AMP SWITCH BINARY CODED

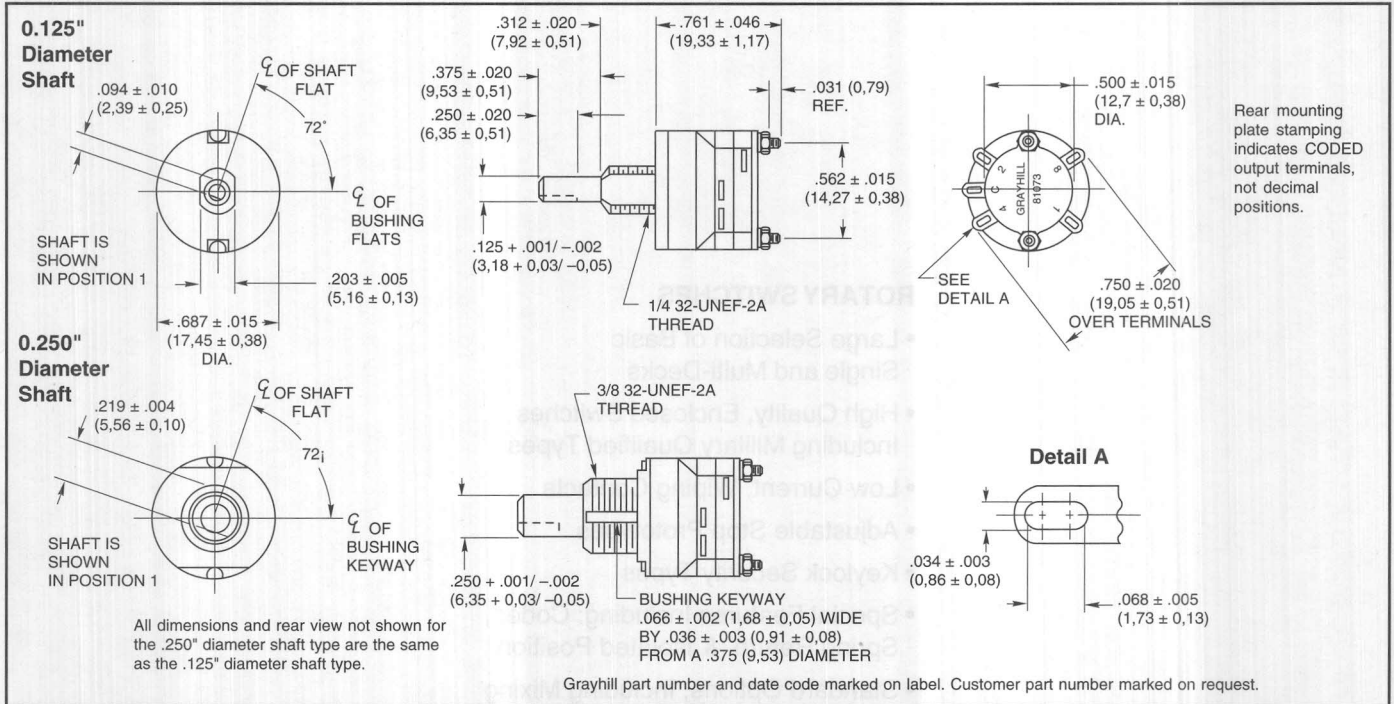
SERIES 71

FEATURES

- 25,000 Cycles At 125 mA
- BCD Code With Optional Seal
- Adjustable Stop Versions
- 1/4" or 1/8" Shaft Diameters



DIMENSIONS In inches (and millimeters)



CODE AND TRUTH TABLE

Output Terminal	0	1	2	3	4	5	6	7	8	9
1		●		●		●		●		●
2			●	●			●	●		
4					●	●	●	●		
8									●	●

● Indicates contact is made to the common.

SPECIFICATIONS

Electrical Rating

Rated: To make and break 125 mA at 30 Vdc resistive at standard conditions

Life Expectancy: 25,000 cycles at rated load; 50,000 cycles mechanical. For ratings at different loads and conditions, contact Grayhill.

Contact Resistance: 100 milliohms maximum (50 milliohms initially)

Insulation Resistance: As measured between mutually insulated parts

Initially 50,000 megohms minimum

After Life 10,000 megohms minimum

Voltage Breakdown: 500 Vac between mutually insulated parts

Carry Current: These switches will carry 3 amperes with a maximum contact temperature rise of 20°C.

SHAFT AND PANEL SEAL

Shaft is sealed by O-ring inside the bushing; panel is sealed by O-ring at the base of the bushing. Seals do not alter dimensions as shown in the drawing when switch is mounted. Panel seal is silicone rubber. Shaft seal is an O-ring per MIL-P-5516B. Shaft and panel seal is not available on adjustable stop switch.

Additional Characteristics

Rotational Torque: 8 to 16 ounce-inches

Contacts: Non-shortening wiping contacts

Shaft Flat Orientation: As shown in the drawing, switch would provide a decimal 1 output.

Materials and Finishes

Base: Diallyl per MIL-M-14

Rotor Mounting Plate: Thermoplastic.

Rotor Contact: Phosphor Bronze, gold plate 30 microinches minimum

Terminals: Brass, gold plate 20 microinches minimum over silver plate 300 microinches minimum

Additional Materials: Other switch materials and finishes are the same as listed for the standard switch. See Standard Switch.

ADJUSTABLE STOP SWITCHES

Adjustable stop switch let s you limit the number of positions. Remove and relocate pins in the front plate. A sticker holds the pins in place. With the exception of holes in the front plate, all dimensions, ratings, and characteristics are the same as the other Series 71 coded switches. For diagrams, see Standard Switch.

ORDERING INFORMATION

Shaft Diameter And Description	Part Number
1/8" Continuous Rotation	71AY23401
1/8" Cont. Rot., Sealed	71AY23402
1/4" Continuous Rotation	71BY23403
1/4" Cont. Rot., Sealed	71BY23404
1/8" Adjustable Stops	71AD36-3118
1/4" Adjustable Stops	71BD36-3119

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

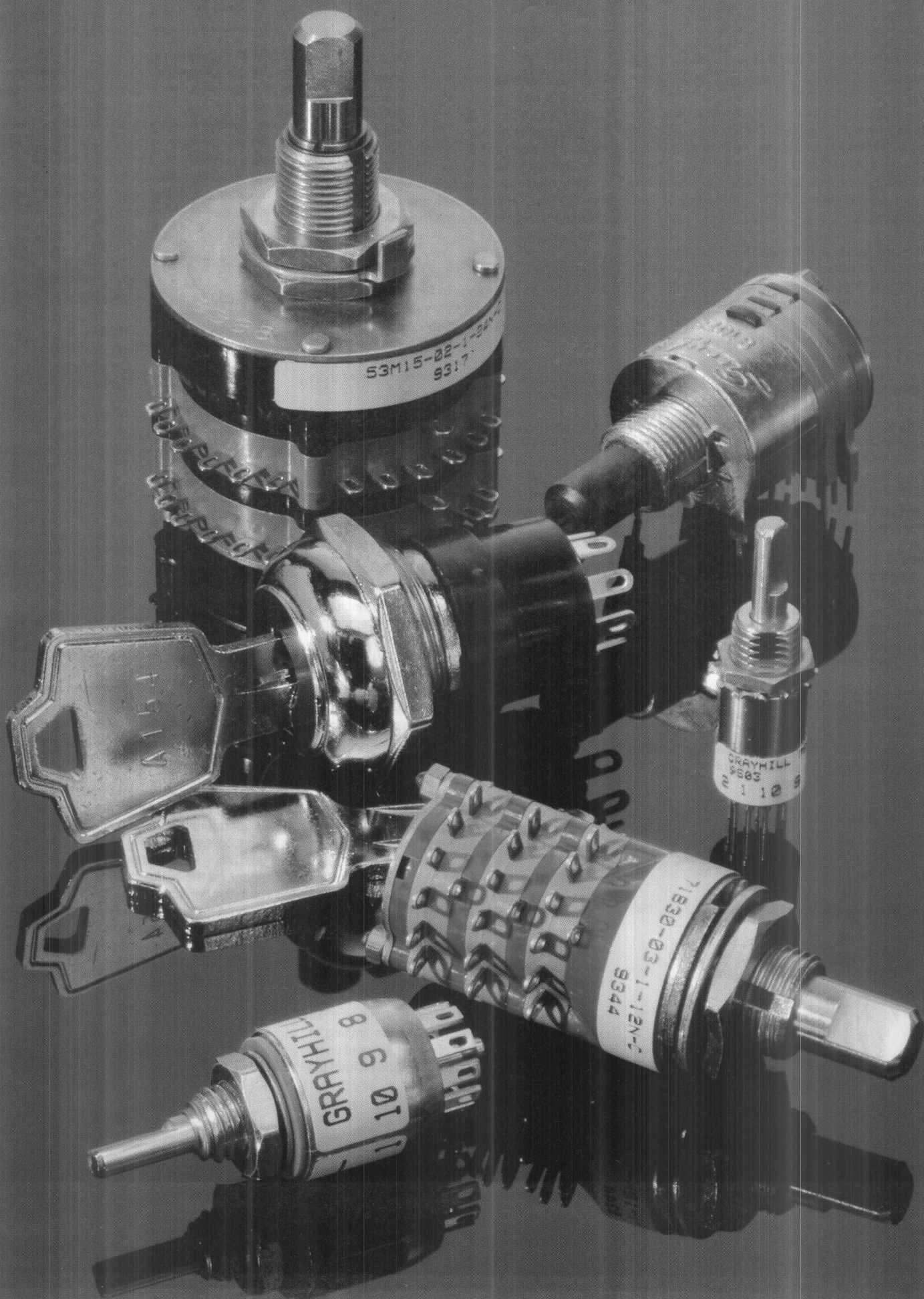
STANDARD SWITCH PAGES

Series 71 Switch begins on page F-29.

ROTARY SWITCHES

- Large Selection of Basic Single and Multi-Decks
- High Quality, Enclosed Switches Including Military Qualified Types
- Low Current, Wiping Contacts
- Adjustable Stop Prototypes
- Keylock Security Types
- Special Features Including: Coded, Spring Return, & Isolated Position
- Standard Options, Including Mixing of Contacts, Shielding, Homing

ENGINEERING INFORMATION.....	F-3
ADJUSTABLE STOP SWITCHES.....	F-6
SELECTION	F-7
STANDARD OPTIONS.....	F-9
SINGLE DECK (1 Deck Only) SWITCHES.....	F-11
MULTI DECK (1 Thru 12 Deck) SWITCHES.....	F-27
KEYLOCK SWITCHES.....	F-63
SPECIAL FUNCTION ROTARY SWITCHES.....	F-79



CATALOG RATINGS

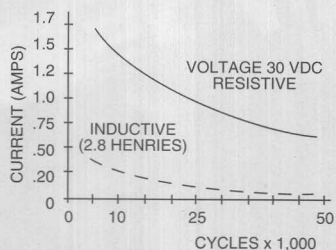
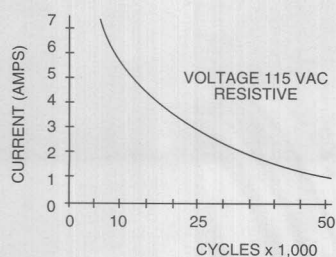
Are Catalog Ratings Misleading? In most cases, yes. Load and life ratings shown in most catalogs are usually invalid for most applications. This results from the complex interplay of such factors as environment, duty cycle, life limiting or failure criteria, actual load, etc. Circuit designers should be aware of these factors, and the effect they have on the useful life of the switch in their applications.

The problem of switch rating arises from the wide variety of requirements placed on the switch. This includes various applications, and the sensitivity of the switch to change in requirements. If we attempted to establish life ratings for all possible applications, we would have an almost infinite variety of ratings.

To simplify the problem, switch manufacturers, switch users, and the military, have established certain references for ratings. These include loads, life requirements, environments, duty cycles, and failure criteria. These references are arbitrarily established. But, they allow you to compare different switch designs. They do not, however, match the actual requirements for most applications.

The curves shown here are an example of some of the life load curves. These curves are life load characteristics of the GRAYHILL 42M and 44M switches. Note that the curves consider only two voltage sources and two types of loads. These voltages and loads are, however, considered as standards for testing procedures by the industry.

Curve data is based on tests conducted at seal level, 25°C and 68% relative humidity. Cycle = 360° rotation and return. Cycling rate is 10 cycles per minute. Switch rating is for non-shorting contacts.



These curves allow you to predict the expected life of the switch once you know the voltage, current and type of load. Also note that each cycle is approximately a 360° of rotation and a return. For a ten position switch this would be a rotation from position 1 to position 10 and back to 1. This cycle runs approximately ten times a minute. Thus testing causes more electrical and mechanical wear than what the switch incurs in actual use.

Summary

The life and load ratings in this and other catalogs are probably not totally valid for your application. The bright side of the picture is that in most applications the switch will perform better than its ratings. This is because the standard industry test conditions are more stringent than those found in most applications.

This difference can be very dramatic. For example, GRAYHILL's 42A and 44A Series Rotary Switches, are rated at 1 ampere (115 Vac resistive). However, they will operate at 5 amperes in many applications. To see how some major factors influence switch performance, read on.

USEFUL LIFE CRITERIA

The "useful" life of a switch in your application depends on what you demand of it. This includes parameters such as contact resistance, insulation resistance, torque, detent feel, dielectric strength, and many other factors. For example, a contact resistance of 50 milliohms may be totally unusable in certain applications such as a range switch in a micro-ohm meter. In other applications a contact resistance of 5 ohms may be perfectly satisfactory.

In establishing "useful" life for a switch in your application, you must first determine "failure criteria," or "end of life" parameters. At what level of contact resistance, dielectric strength, etc., is the switch no longer acceptable for your application?

Most switches are acceptable on all parameters when new. There is a gradual deterioration in performance with life. The rate of deterioration varies greatly with basic switch design. Often, circuit designers select a switch on the basis of its performance when new. This is a mistake. The performance of the switch after several years of equipment use is more significant. To estimate this, first determine the life limiting or failure criteria for your application. In most uses, important life-limiting (failure) criteria include the following parameters:

- Contact Resistance
- Insulation Resistance
- Dielectric Strength
- Actuating Force

Contact Resistance

This is the resistance of a pair of closed contacts. This resistance effectively appears in series with the load. Typical values are in the range of a few milliohms for new switches. These values usually increase during life. The rate of increase is greatly affected by the voltage, current, power factor, frequency, and environment of the load being switched. Typical industry standard "end of life" criteria for this parameter are:

MIL-S-3786	20 milliohms (Rotary Switches)
MIL-S-6807	20 milliohms (Snap Pushbuttons)
MIL-S-8805	40 milliohms (Pushbuttons)
MIL-S-83504	100 milliohms (DIP Switches)

Contact resistance can be measured by a number of different methods. All of them are valid depending upon the switch application and the circuit. GRAYHILL uses the method in applicable military specifications. This method specifies an open circuit test voltage and a test current. The voltage drop across the closed contacts is measured. The contact resistance is determined by Ohm's Law from the test current and the measure voltage drop. MIL-S-3786, MIL-S-6807 and MIL-S-8805 require a maximum open circuit test voltage of 2 Vdc; they require a test current of 100 milliamperes. MIL-S-83504 requires a maximum test voltage of 50 millivolts and a test current of 10 milliamperes.

When a switch is rated to make and break 5 or more amperes, there is a difference. Contact resistance is determined by measuring the voltage drop while the switch is carrying the maximum rated current.

The voltage drop that occurs across the contacts determines, in part, the contact temperature. If the temperature rise of the contacts is sufficient, it affects contact material. A chemical reaction will take place that can cause an insulating film to appear on the contacts. This film is present between the contacts during the next switching operation. This film formation can cause failure due to increasing contact resistance. For switching of very low voltages and currents, this resistance may be the failure criteria.

Insulation Resistance

This is the resistance between two normally insulated metal parts, such as a pair of terminals. It is measured at a specific high DC potential, usually 100 Vdc or 500 Vdc. Typical values for new switches are in the range of thousands of megohms. These values usually decrease during switch life. This is a result of build-up of surface contaminants. Typical industry standard "end of life" criteria for the parameter are:

MIL-S-3786	1000 megohms (for plastic insulation)
MIL-S-6807	Not specified
MIL-S-8805	2000 megohms
MIL-S-83504	1000 megohms

Another special test condition is commonly specified. It measures insulation resistance for switches in a high humidity atmosphere (90%-98% R.H.). In this condition, condensation of moisture commonly occurs on the surface of the insulating material. Some types of insulation will absorb varying amounts of moisture. This will normally lower the insulation resistance. Typical industry values for this condition are:

MIL-S-3786	10 megohms (for plastic insulation)
MIL-S-6807	3 megohms after drying
MIL-S-8805	10 megohms (for plastic material)
MIL-S-83504	10 megohms

Dielectric Strength

This is the ability of the insulation to withstand high voltage without breaking down. Typical values for new switches in this test are in excess of 1500 Vac RMS. During switch life, contaminants and wear products deposit on the surface of the insulation. This tends to reduce the dielectric withstanding voltage. In testing for this condition, a voltage considerably above rated voltage is applied. Then, the leakage current is measured at the end of life. Typical industry standard test voltages and maximum allowable leakage currents are as follows:

MIL-S-3786	1000 Vac and 1 mA maximum leakage
MIL-S-6807	600 Vac RMS after life 10 microamperes maximum leakage
MIL-S-8805	1000 or 1000 plus twice working voltage (AC) RMS and 1mA maximum leakage
MIL-S-83504	500 Vac and 1 mA maximum leakage
UL Standard	900 Vac without breakdown (UL Standard dependent on test)

Voltage breakdown is another method for describing the ability of the insulating material to withstand a high voltage. Voltage breakdown describes the point at which an arc is struck and maintained across the insulating surface with the voltage applied between the conducting members.

ADDITIONAL LIFE FACTORS

Effect of Loads

On any switch, an arc is drawn while breaking a circuit. This causes electrical erosion of the contacts. This erosion normally increases contact resistance and generates wear products. These wear products contaminate insulating surfaces. This reduces dielectric strength and insulation resistance.

The amount of this erosion is a function of current, voltage, power factor, frequency and speed of operation. The higher the current is, the hotter the arc and the greater the erosion. The higher the voltage is, the longer the arc duration and the greater the erosion.

Inductance acts as an energy storage device. This returns its energy to the circuit when the circuit is broken. The amount of erosion in an inductive circuit is proportionate to the amount of inductance. Industry standard test inductance as described in MIL-I-81023 is 140 millihenries. Other test loads include 250 millihenries and 2.8 henries.

Frequency can also affect erosion. The arcing ends when the voltage passes through zero. To a certain extent, the following is true. The higher the frequency, the sooner arcing ends, the lower the erosion.

The speed of operation affects the duration of the arc. Fast operation can extinguish the arc sooner. This reduces the erosion, unless the air within the switch is completely ionized.

Actuating Force

Rotational torque is the actuating force required to turn a rotary switch through the various positions. For pushbutton or DIP switches, it is the force required to depress the button, or move the actuator between positions. The actual torque or force required depends on the design of the switch. It varies widely from one design to another. See appropriate MIL Specs or manufacturers literature for typical industry values for specific designs.

When torque or force values are specified, it is customary to give a minimum and maximum value. During life, two offsetting factors may occur to change the initial value. Relaxation of spring members will tend to lower torque or force values. Wear or "galling" of mating surfaces, however, may tend to increase these values. Typical end of life specifications may require the switch to fall within the original range. Or, they may specify a maximum percentage change from original value. For example, "the rotational torque shall not change more than 50% from its initial value."

Effect of Ambient Temperature

Temperature extremes may affect switch performance and life. Very high temperatures may reduce the viscosity of lubricants. This allows them to flow out of bearing areas. This can hasten mechanical wear of shafts, detents, plungers, and cause early mechanical failure. Contact lubricants are sometimes used. Too little lubrication can result in a high rate of mechanical wear. Too much lubrication flowing from other bearing areas can adversely affect dielectric strength and insulation resistance.

Through careful design and selection of lubricants most manufacturers attempt to minimize these affects. Nevertheless, continual operation in high ambient temperatures will shorten the life of a switch regardless of design.

Extremely low ambient temperatures may also create problems. Low temperatures may cause an increase in the viscosity of the contact lubricant. Higher viscosity can delay or prevent the closing of contacts, causing high operating contact resistance. Under certain atmospheric conditions, ice may form on the contact surfaces. This also causes high and erratic contact resistance.

Neither of these conditions may materially reduce the life of the switch. However, it may cause unsatisfactory operation. If the voltage of the circuit is high enough, it can break down the insulating layer. Some current will flow through the high resistance contacts. A local heating action is created, which tends to correct the condition in a short period of time.

Switches with high contact pressures may minimize the low ambient temperature effect. This is particularly true if the application calls for switching signal level voltages and currents.

Effects of Altitude

In high altitudes, barometric pressure is lower. Low pressure reduces the dielectric strength of the air. The arc strikes at a lower voltage and remains longer. This increases contact erosion. Switches for use in high altitudes will therefore require de-rating in terms of loads and/or life.

Effects of Duty Cycle

Mechanical life testers cause accelerated life testing. Testers operate switches at a rate of approximately 10 cycles per minute. This rate is greatly in excess of normal manual operation in equipment. It constitutes a severe test of the switch.

Lubricants do not have an opportunity to redistribute themselves over the bearing surfaces at this duty cycle. The contact heating caused by arcing does not have a chance to dissipate.

Then how do you know if a switch will give reliable performance in your application?

How do you know if it will last the life of your equipment?

Ask the switch manufacturer. GRAYHILL, and most other reputable manufacturers have compiled vast quantities of test data. We are in a position to give a good estimate of a switch's performance in many nonstandard applications. You should provide the following data:

Expected Life Load	in number of cycles voltage, current, power factor, and frequency
Operation	manual or mechanical, duty cycle
Application	type of equipment
Environment	altitude, ambient temperature range relative humidity, corrosive atmosphere, shock, vibration, etc.
Failure Criteria	end of life contact resistance, dielectric strength, insulation resistance, etc.

With this information, we can usually estimate if a given switch is suitable for your application.

thin, hard flux coats the contact surface after the solvent evaporates. Additionally, solvents may dissolve and wash away lubricants in switches. Lubricant loss may prevent proper mechanical action.

Exercise similar precautions when you mount a switch to a printed circuit board. Maintain proper solder temperatures and follow proper cleaning techniques. Avoid subjecting these switches to lengthy solder baths. The excessive heat can deform the plastics.

RF/EMI SHIELDING

Some applications require shielding against Radio Frequency Interference and/or Electro-Magnetic Interference. Experts feel that the most effective way to achieve shielding is to provide a conductive bridge across the component mounting hole. They also generally agree that there is no good method for testing shielding. So, the equipment manufacturers themselves must identify and solve specific problems. Component manufacturers can generally assist in the solution of shielding problems.

Whenever possible, use standard switches and contact configurations. Standards provide the greatest economy and the best delivery. When you need a deviation, it pays to consult with your suppliers as soon as possible. At the early stages of the design, there are many low cost options for achieving the results. At the late stages of design, some of the options may no longer be open. For example, size may be restricted. This might result in a more costly redesign.

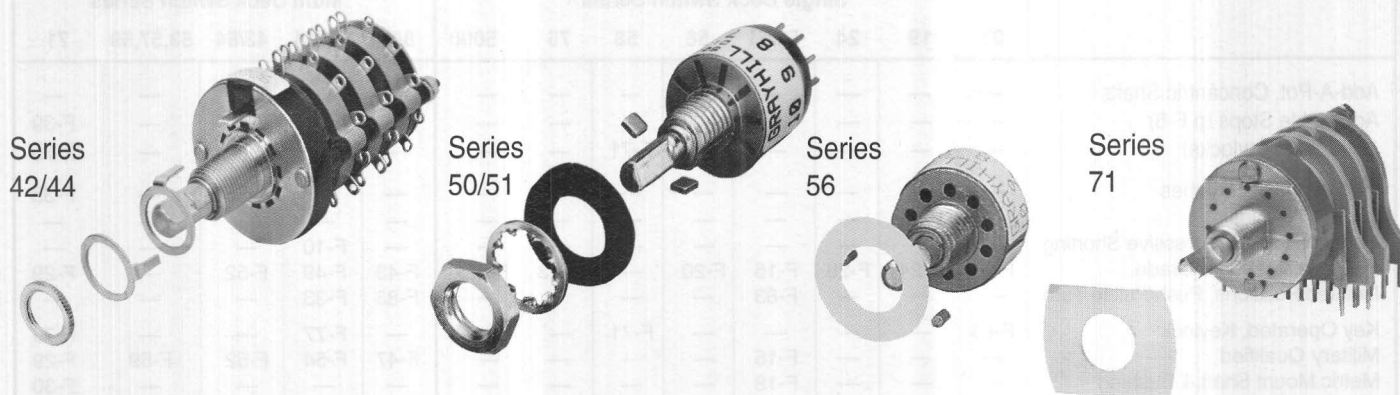
Typical standard rotary options are as follows: coded contacts, homing rotor effect, progressively shorting contacts, PC mountable terminals, rotary switch spring return positions, and push-to-turn or pull-to-turn mechanisms.

Limited panel space may be solved by a concentric shaft rotary switch. It is two rotary switches, located one behind the other. There are other concentric shaft possibilities. A rotary switch can be combined with another component. These include a potentiometer, a pushbutton switch, and a mechanical element. The most cost effective design may be one of these concentric options. But, selection must be made at the outset of equipment design.



FEATURES

- Quick Route to Rotary Switches
- For Prototypes and Small Production Runs



BEST AVAILABILITY

The Problem

Procurement lead time on rotary switches for prototypes and small production runs can be long. This is often a source of headache for design engineers and production control managers.

GRAYHILL makes more than 300,000 combinations of rotary switch styles; number of decks, poles per deck, positions per pole, military qualified or commercial grade, etc. This wide variety makes it impractical for either distributors or manufacturers to stock completed switches. Consequently, even small quantities must be built to order.

The Solution

GRAYHILL Electronic Distributors can supply a wide variety of rotary switches with Adjustable Stops. This feature gives you a switch immediately with exactly the electrical properties you need. These Adjustable Stop switches have the

basic mechanical characteristics of their fixed stop counterparts. To get the right number of positions per pole for your application, simply adjust the stop washers or stop pins.

By stocking a few switches, the Distributor provides over 100,000 possible combinations of switches. This includes the popular styles, sizes, angles of throw, number of decks, poles per deck, positions per pole, and types of contacts. Availability of these switches through Distributors speeds prototype development time. There is no time lag in waiting for factory made samples.

The Substitution

Writing an equivalent part number is easy. To obtain an adjustable-stop equivalent to a fixed-stop rotary switch you must substitute style letters and possibly series number. Then replace the positions-per-pole number in the fixed-stop number with the letters AJ. See the examples for the scheme.

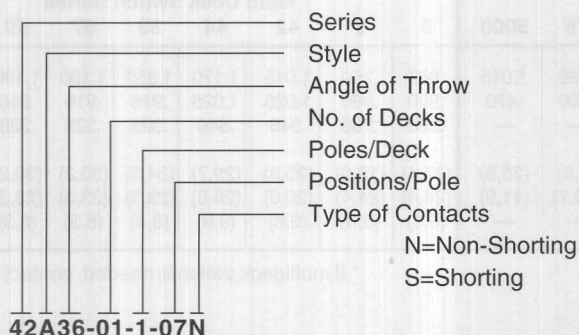
When adjustable equivalents apply, the rotary switch pages will indicate the substitutions. A chart will show the fixed stop rotary switch series, style and angle of throw as well as the adjustable stop rotary switch series, style and angle of throw. Then the letters AJ in the positions-per-pole location, gives you the part number of the equivalent.

Suppliers

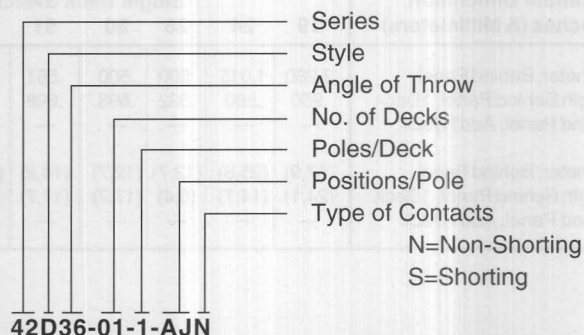
Distributors can supply 1 and 2-deck adjustable-stop switches from stock (one or two poles per deck). And, they can quickly secure other variations from factory stock. Reduce prototype development time. Use GRAYHILL Adjustable Stop Rotary Switches for all of your prototype requirements.

These electronic distributors also maintain a representative stock of GRAYHILL products. Local availability can often "save the day", and simplify your paperwork. For a list of GRAYHILL Distributors in your area see Section A.

Fixed Stop Rotary Switch



Adjustable Stop Equivalent



SELECTOR CHARTS

1. SELECT A FEATURE

Since there are fewer switches with certain features, using this chart first will help you narrow your selection more quickly.

FEATURES

	Single Deck Switch Series								Multi Deck Switch Series				
	03	19	24	50/51	56	58	75	5000	8/9	42/44	43/54	53,57,59	71
Add-A-Pot, Concentric Shafts	—	—	—	—	—	—	—	—	—	—	F-52	—	—
Adjustable Stops (p.F-6)	—	—	—	—	F-20	—	—	—	—	F-51	F-51	—	F-39
AntiStatic (Keylocks)	—	—	—	—	—	F-71	—	—	—	—	—	—	F-75
Concentric, 2 Switches	—	—	—	—	—	—	—	—	—	—	F-52	—	F-35
Faston Terminals	—	F-24	—	—	—	—	—	—	—	—	—	—	—
Homing Rotor, Progressive Shorting	—	—	—	—	—	—	—	—	—	F-10	—	—	—
Industrial/Standard Grade	F-65	F-24	F-26	F-15	F-20	—	F-13	F-25	F-43	F-49	F-52	—	F-29
Isolated Positions, Push/Pull to Turn	—	—	—	F-83	—	—	—	—	F-83	F-33	—	—	—
Key Operated, Keylock	F-65	—	—	—	—	F-71	—	—	—	F-77	—	—	F-75
Military Qualified	—	—	—	F-15	—	—	—	—	F-47	F-54	F-52	F-59	F-29
Metric Mount Shaft & Bushing	—	—	—	F-18	—	—	—	—	—	—	—	—	F-30
Optically Coupled	—	—	—	—	—	—	—	—	—	—	—	—	—
Progressively Shorting	—	—	—	—	—	—	—	—	—	F-10	—	—	—
Screwdriver Slotted Shaft	—	—	—	F-18	F-20	—	F-13	—	—	—	—	—	—
Sealed, Shaft and Panel	—	—	—	F-18	F-20	—	—	—	F-47	F-51	—	F-59	F-29
Sealed, Process	—	—	—	F-18	—	—	—	—	—	—	—	—	F-34
Terminals, PC Mount	—	—	F-26	F-15	F-20	F-71	F-13	—	F-45	—	—	—	F-31
Terminals, Solder Lug	F-65	F-24	F-26	F-15	F-20	F-71	—	F-25	F-43	F-49	F-52	F-59	F-29
Shorting & Non-Shorting	—	N	N&S	N&S	N&S	N&S	N	N&S	N&S	N&S	N&S	N&S	N&S
Spring Return, Momentary	—	—	—	F-81	—	—	—	—	F-81	E-81	—	—	—
UL Recognized	—	F-24	—	—	—	—	—	—	—	F-49	F-49	—	—

2. SELECT A FACTOR

Begin with the table most important to you. If two or more series solve your, rating, size, or circuitry need, use the price chart to decide.

FACTOR: CURRENT LIFE RATING

All switches are rated to make and break at least 100 milliamperes for 10,000 cycles of operation. Rating becomes a matter of interpretation. Carefully review the Engineering Information on the previous pages. Ratings which assure a different life are possible; contact GRAYHILL.

	Single Deck Switch Series							Multi Deck Switch Series				
	19	24	26	50/51	56	75	5000	8/9	42/44	43/54	53,57,59	71
>1 Million Cycles At Rated Load	—	—	—	—	—	—	—	—	—	—	—	—
25,000 Cycles At Load (Amps)	—	1	LL**	.050	—	—	1	.250	1,3,5*	1,3,5*	—	.250
10,000 Cycles At Load (Amps)	—	—	LL**	.200	.200	.100	—	.500	1,3,5*	1,3,5*	.150, .250*	—
6,000 Cycles At Load (Amps, UL)	15	—	—	—	—	—	—	—	—	—	—	—

* Varies with angle of throw and style.

**Logic Level loads.

FACTOR: SIZE

Maximum Dimension In Inches (& Millimeters)	Single Deck Switch Series								Multi Deck Switch Series							
	19	24	26	50	51	56	75	5000	8	9	42	44	53	57	59	71
Diameter, Behind Panel	2.280	1.015	.500	.500	.561	.500	.298	1.015	.687	.750	1.015	1.170	1.350	1.190	1.190	.750
Length Behind Panel, 1Deck	.950	.580	.332	.698	.698	.355	.500	.470	.960	.960	1.025	1.025	.916	.916	.916	.760
Behind Panel, Add'l Deck	—	—	—	—	—	—	—	—	.268	.268	.346	.346	.329	.326	.326	.218
Diameter, Behind Panel	(57,9)	(25,8)	(12,7)	(12,7)	(14,2)	(12,7)	(7,6)	(25,8)	(17,4)	(19,0)	(25,8)	(29,7)	(34,3)	(30,2)	(30,2)	(19,0)
Length Behind Panel, 1Deck	(24,1)	(14,7)	(8,4)	(17,7)	(17,7)	(9,0)	(12,7)	(11,9)	(24,4)	(24,4)	(26,0)	(26,0)	(23,3)	(23,3)	(23,3)	(19,3)
Behind Panel, Add'l Deck	—	—	—	—	—	—	—	—	(6,8)	(6,8)	(8,8)	(8,8)	(8,4)	(8,3)	(8,3)	(5,5)

* If multideck switch is needed, contact Grayhill.

12	30°	12	6	N or S	Solder	44
12	30°	1	4	N or S	Both	51
12	30°	1	4	N or S	Both	56
11	30°	1	1	N	****	19
10	36°	12	2	N or S	Both	8
10	36°	12	2	N or S	Both	71
10	36°	12	2	N or S	Both	42
10	36°	1	2	N	PC	75
10	36°	1	2	N or S	Both	50
10	36°	1	2	N or S	Both	56
10	36°	1	1	N or S	Both	24
10	36°	1	1	N or S	Solder	5000
8	45°	12	4	N or S	Both	9
8	45°	12	4	N or S	Solder	44
8	45°	1	2	N	Both	50
6	60°	6	3	N	Both	9
6	60°	12	3	N	Solder	44
6	60°	1	2	N	Both	50
4	90°	12	2	N	Solder	44
4	90°	6	2	N	Both	9
4	90°	1	2	N	Both	50

* Maximum positions per pole depends on number of poles per deck.

** Based on 1 pole per deck. Number of decks is also limited by the total number of poles.

*** Limited by total number of poles per switch.

****Choice of Faston or Solder Lug terminals.

FACTOR: RELATIVE PRICE

This listing is provided to help you decide between several switches which might otherwise meet your needs. Coded switches are not included. Relative price multiplier is based on rotary switches with 1 pole per deck and 6 positions per pole in lots of 100. While actual prices vary, relative price remains more constant.

Switches are listed from least expensive to most expensive, with item number 1 being the least expensive. Other listings show a multiple of that price. For example, a series 50 military qualified switch is about twice the expense of a series 56 switch, although they switch about the same current in a .5 inch diameter package.

For actual prices and discounts, contact a local sales office, an authorized local distributor, or Grayhill.

Price Rank	Relative Price	Series Number	Switch Grade
1	1.0x	56	Standard
2	1.1x	24	Standard
3	1.3x	5000	Standard
4	1.5x	50	Standard
5	1.6x	51	Standard
6	1.6x	71	Standard
7	1.7x	71	Military
8	1.7x	75	Standard
9	2.0x	50	Military
10	2.1x	51	Military
11	2.2x	19	UL/Standard
12	2.5x	8 & 9	Standard
13	2.7x	42 & 44	UL/Standard
14	3.1x	42 & 44	Military
15	3.2x	8 & 9	Military
16	3.9x	53,57,59	Military

THEN

PROCEED TO THE SPECIFIC CHOICES & LIMITATIONS CHART

Series	Page	Series	Page
3	F-65	53	F-59
8	F-43	54	F-49
9	F-43	56	F-20
19	F-24	57	F-59
24	F-26	58	F-71
42	F-49	59	F-59
43	F-49	71	F-29
44	F-49	75	F-13
50	F-15	5000	F-25
51	F-15		

For special feature switches such as coded, spring return, isolated positions, and keylocks, see the pages referenced in the FEATURES chart on the facing page.



— — — — —

* See description below for limitations.

11. Intermixing of Shorting and Non-Shorting Contacts

In some switches, non-shorting and shorting contacts can be intermixed between decks. A 2 deck switch, for example could have shorting contacts on deck 1 and non-shorting contacts on deck 2. In a few switches, non-shorting and shorting contacts can also be intermixed between poles. A 2-pole per deck switch, for example, could have non-shorting on pole #1, and shorting on pole #2.

Series 8 and 9:

A 9M30 or 8M36 rotary switch can have shorting and non-shorting contacts intermixed between decks. Shorting and non-shorting contacts can be intermixed between poles as well as decks in styles A, S, P, and SP.

Series 42, 43, 44, and 54, in 30° or 36°:

Non-shorting and shorting contacts can be intermixed between poles or decks.

Series 50, 51, and 56:

Non-shorting and shorting contacts can be intermixed between poles.

Series 71:

Non-shorting and shorting contacts can be intermixed between poles in fixed stop switches only.

Priced the same as standard switches. The type of contacts on each pole must be precisely indicated.

12. PC Mount Switches With Terminals From One Side of Switch

Series 71 PC mount switch has all terminals on one side.

Series 8P, 9P, and 42P with non-shorting contacts are also available with terminals limited to one side. Contact Grayhill for a special part number. This is accomplished by using 2 decks per pole and placing the rotating contacts 180° out of phase on each deck. The first deck picks up the first half of the positions; the second deck picks up the last half of the positions. Common terminals are tied together by the PC board circuitry.

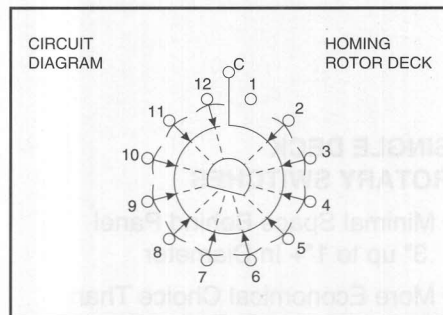
A total of 12 decks (6 usable poles) is the maximum per switch. Switches with the maximum number of positions (12 for 30°, or 10 for 36°) will have continuous rotation. Rotation can be limited to less than the maximum positions. For example, a 8-position Series 8P36 switch with terminals on one side, would pick up 5 positions on the first deck and 3 positions on the second deck.

Priced the same as standard switches with comparable number of decks and positions. Example: an 8P36, 1-pole, 10 position switch with

terminals on one side of the switch would be priced as a 2 deck, five position, one poles per deck switch.

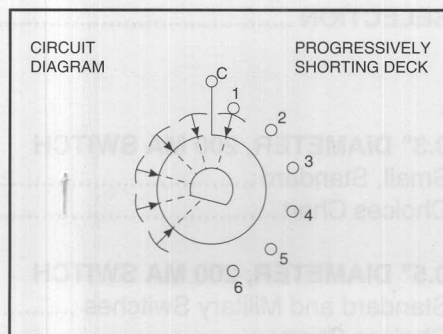
13. Homing Rotor (Bridging and Shorting Deck) and Progressively Shorting Deck

A homing rotor (bridging and shorting) switch deck connects all terminals to the common except the terminal in the selected switch position. For example, in position 1, terminals 2 thru 12 are connected to the common, and terminal 1 is



open. In position 2, terminal 3 thru 12 and 1 are connected to the common, and terminal 2 is open. A homing rotor deck will function for 25,000 mechanical cycles of operation.

The progressively shorting switch deck connects consecutive switch positions to the common. For example, in position 1, terminal 1 is connected to the common; in position 2, terminals 1 and 2 are connected to the common; in position 3, terminals 1, 2, and 3 are connected to the common. A



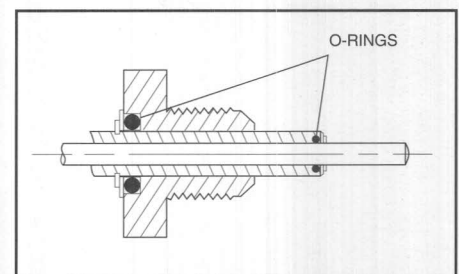
progressively shorting deck is limited to a maximum of 6 positions. A progressively shorting deck will function for 25,000 mechanical cycles of operation.

Homing Rotor or Progressively Shorting decks can be ordered as a deck of a 44A or 44M style switch, or their sealed equivalents. Order up to 11 conventional decks and 1 special circuitry deck. For a good detent feel, the switch is limited to a total of 12 poles plus the homing rotor or progressively shorting deck. Example: 6 2-pole decks and a homing rotor. When these special decks are used in combination with conven-

tional decks, it is important to remember that the stop system limits the rotation of both types of decks. For example, when a homing rotor deck is used in combination with a 6-position conventional deck, the homing rotor is likewise limited to six positions.

14. Shaft and Panel Seal on Concentric Shaft Switches

The following diagram shows the location of the O-rings required to seal the shafts to the bushings. When the concentric shaft switches are sealed in this manner, the .125 inch diameter shaft is supplied full round. Bushing-to-panel sealing is accomplished by the panel seal kit. See page E-45.



15. Fixed Stop, Add-A-Pot Switches

The rotary switch section of the Add-A-Pot rotary switches can be built with a fixed mechanism rather than the standard adjustable stop mechanism. The front end of a switch of this type is similar to the Series 43A or Series 54A style concentric rotary switches. The total number of decks is limited to three. The Series 43 is limited to 1 pole per deck. Series 54 to 2 poles per deck.

16. Series 54 Concentric Shaft Switch in 45°, 60°, and 90° Throws

The Series 54A switch is available with these angles of throw in Section A of the concentric rotary switch. Section B is available in 30° angle of throw only. Section A is limited to 1 to 3 decks, non-shorting contacts, and 1 or 2 poles per deck.

1.1. Introduction of Shoring and Non-Shoring Contacts

In some switches, non-shoring and shoring contacts can be found on the same deck. A shoring contact is a contact that has a shoring contact on its back. A non-shoring contact is a contact that has a non-shoring contact on its back. A shoring contact can be used to shoring a contact. A non-shoring contact can be used to non-shoring a contact.

1.2. Homing Pole (Shoring and Non-Shoring) Switching Deck

A homing pole (shoring and non-shoring) switch deck connects all terminals to the common terminal. The homing pole is a pole that is connected to the common terminal. The homing pole is a pole that is connected to the common terminal. The homing pole is a pole that is connected to the common terminal.



1.3. Fixed Stop, Add-A-Pole Switches

The fixed stop, add-a-pole switches are a type of switch that allows for the addition of poles to an existing switch. The fixed stop switch has a fixed stop that prevents the rotor from rotating further. The add-a-pole switch has a fixed stop that allows for the addition of poles to the switch.

1.4. Series 54 Concentric Shaft Switches

The series 54 concentric shaft switches are a type of switch that have a concentric shaft. The concentric shaft allows for the addition of poles to the switch. The series 54 concentric shaft switches are a type of switch that have a concentric shaft. The concentric shaft allows for the addition of poles to the switch.

SINGLE DECK ROTARY SWITCHES

- Minimal Space Behind Panel .3" up to 1"+ In Diameter
- More Economical Choice Than Multi Deck Rotary Switches
- High Quality, Enclosed Switches Including Military Types
- Low Current, Wiping Contacts

SELECTION F-7

0.3" DIAMETER, 200 MA SWITCH

Small, Standard	Series 75	F-13
Choices Chart	Series 75	F-14

0.5" DIAMETER, 200 MA SWITCH

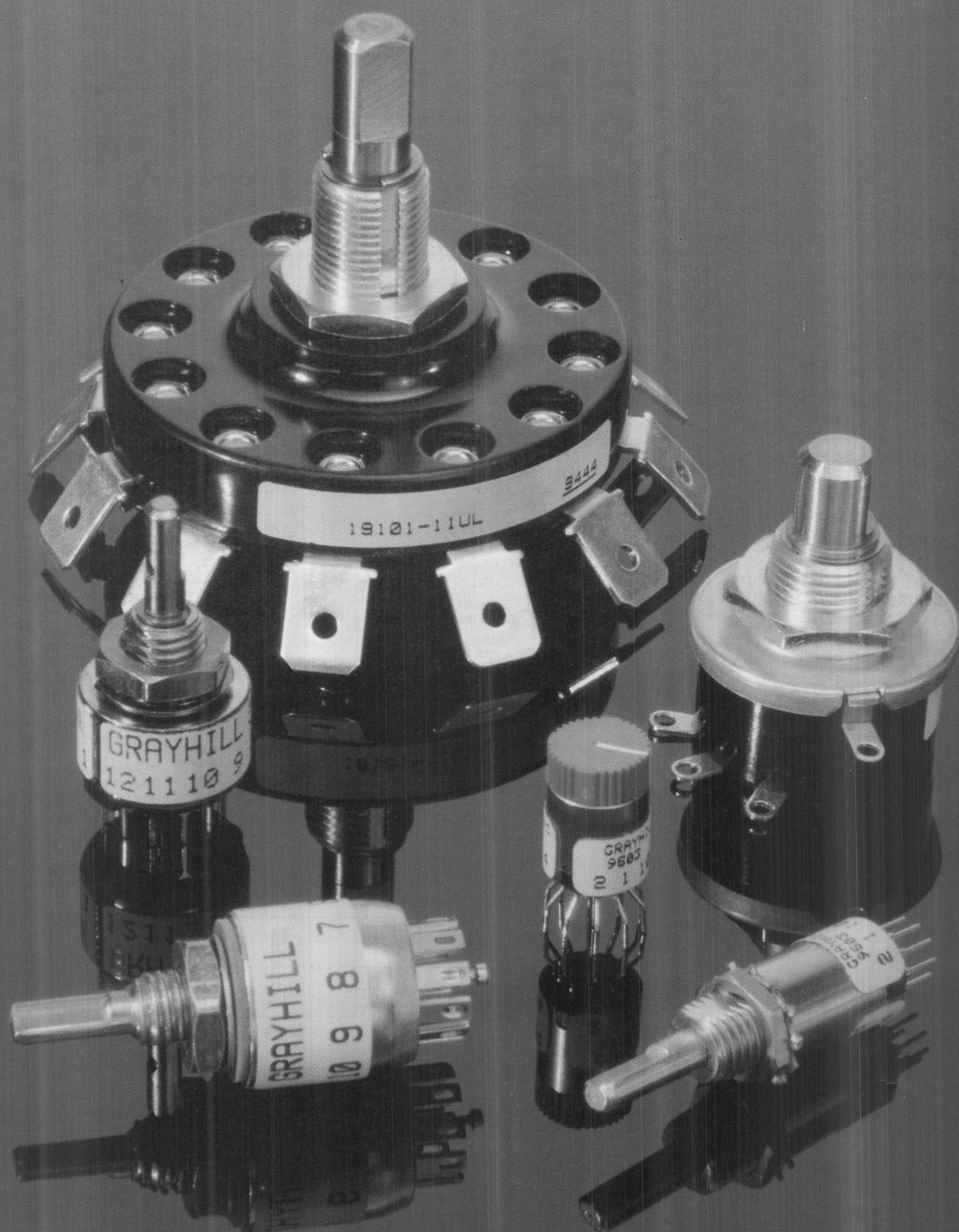
Standard and Military Switches	Series 50 & 51	F-15
Choices Chart	Series 50 & 51	F-19
Economical, Short Behind Panel	Series 56	F-20
Choices Chart	Series 56	F-23

HIGH CURRENT, UL POWER TAP SWITCH

2" Diameter, 15 A	Series 19	F-24
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1" DIAMETER, 1 AMP SWITCHES

Economical Switch	Series 5000	F-25
Positive Detent Switch	Series 24	F-26

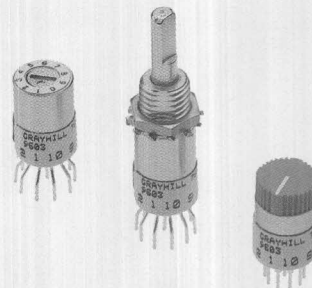


0.3" DIAMETER, 200 MA ROTARY SWITCHES

SERIES 75

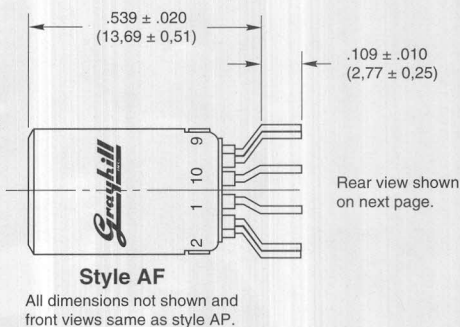
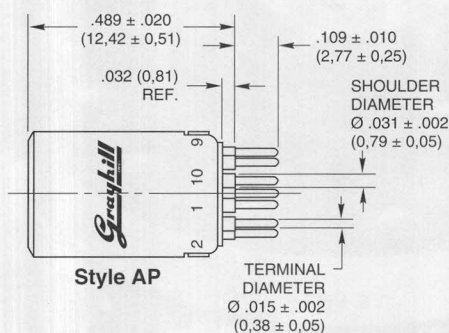
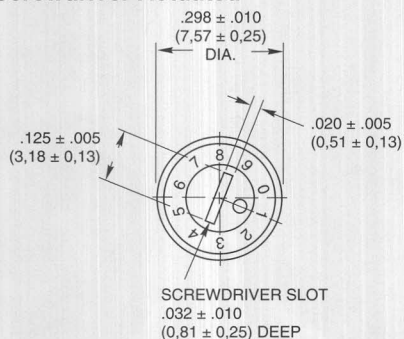
FEATURES

- Small Size
- Flush, Shafted, or Knobbed Shaft



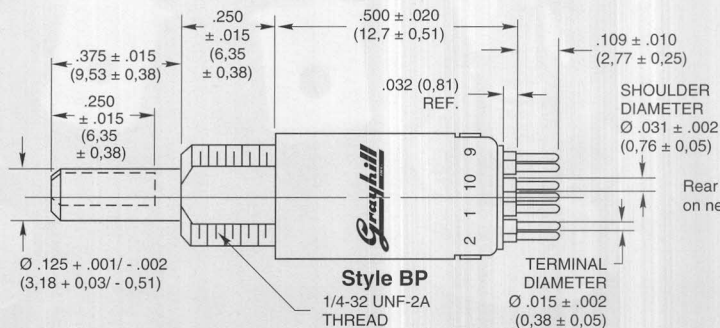
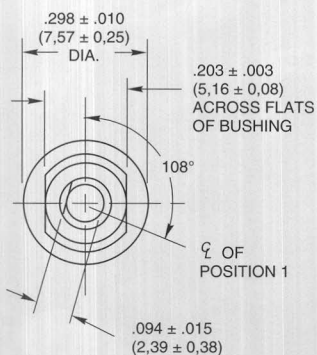
DIMENSIONS In inches (and millimeters)

Screwdriver Actuated



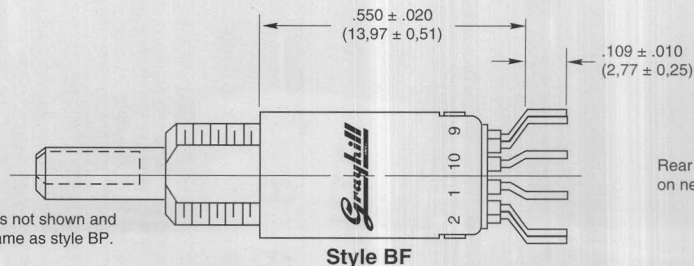
Rear view shown on next page.

Shaft Actuated



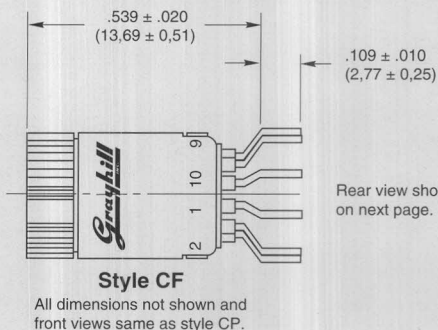
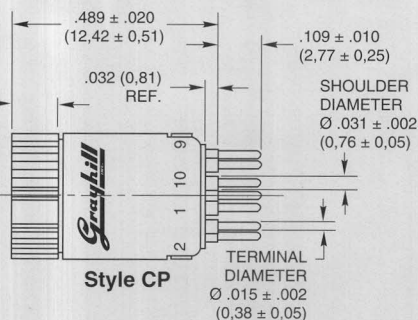
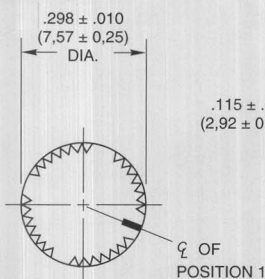
Rear view shown on next page.

All dimensions not shown and front views same as style BP.



Rear view shown on next page.

Integral Knob Actuated

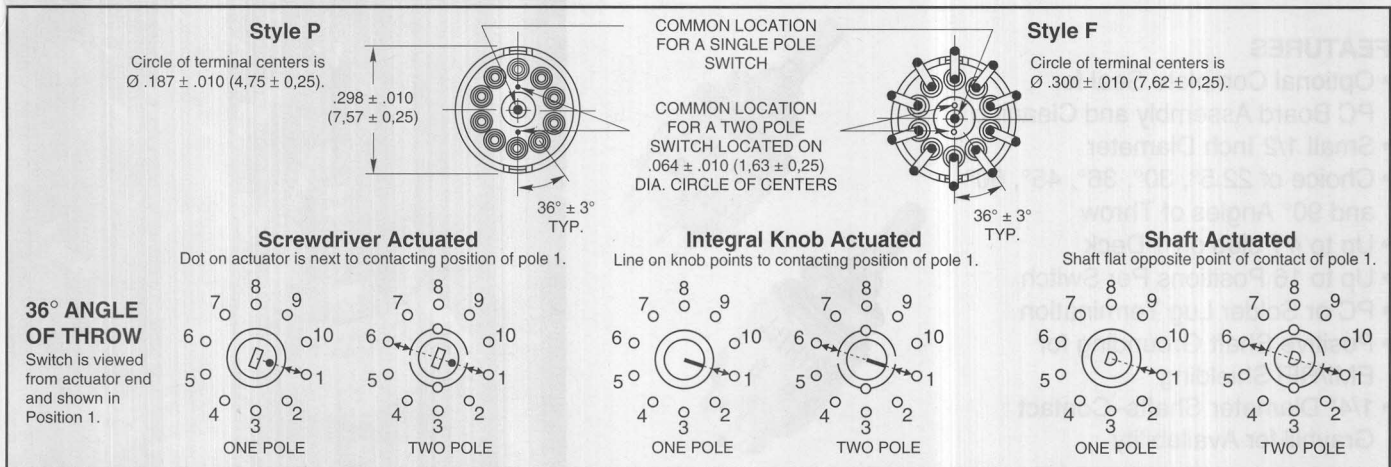


Rear view shown on next page.

Grayhill part number and date code marked on label.
Customer part number marked on request.

0.3" DIAMETER, 200 MA ROTARY SWITCHES

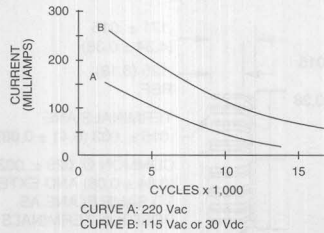
CIRCUIT DIAGRAMS AND REAR VIEWS



SPECIFICATIONS

Electrical Ratings

Chart shown for non-shorting (break before make) contacts, resistive load.



One cycle is 360° rotation and a return through all switch positions to the starting position. The data for the curve was measured at sea level, 25°C and 68% relative humidity with the following limiting criteria:

Contact Resistance: 50 milliohms maximum (15 milliohms initially).

Insulation Resistance: 10,000 megohms minimum between mutually insulated parts.

Voltage Breakdown: 500 Vac between mutually insulated parts.

Life Expectancy: 10,000 cycles at 200 milliamperes. One cycle is 360° rotation and a return through all switch positions to the starting position.

Low Level Rating: Make and break a 50 millivolt, 1 milliamper, resistive load for 10,000 cycles with a maximum contact resistance of 50 milliohms.

Contact GRAYHILL for information if the life limiting criteria is more critical than those listed, if the required cycles of operation are greater than those listed, if a larger make and break current is required than the one listed for the desired number of cycles, or if elevated temperatures or reduced pressures are part of the operating environment.

Materials and Finishes

Base: Diallyl per MIL-M-14

Detent Cover and Detent Rotor in Styles AP, AF, BP, and BF: Phenolic per MIL-M-14

Bushing: Brass, cadmium plated, with yellow chromate

Stop Pin: Stainless steel, passivated

Detent Balls: Steel, nickel plated

Detent and Contact Springs: Tinned music wire

Rotor Contact: Silver cad-oxide, gold plated
Terminals and Common: Brass, Gold plate .00002" minimum thickness over Silver plate .0003" minimum.

Shaft in Style BF or BP: Zinc, nickel plated.

Integral Knob and Detent Rotor in Style CF or CP: Red Thermoplastic

Mounting Hardware for Style BF or BP: One mounting nut .062" thick by .312" across flats and one internal tooth lockwasher supplied with each switch. Mounting nut is brass, cadmium plated and lockwasher is spring steel, cadmium plated.

Additional Characteristics

Contact Type: Non-Shorting, wiping contacts

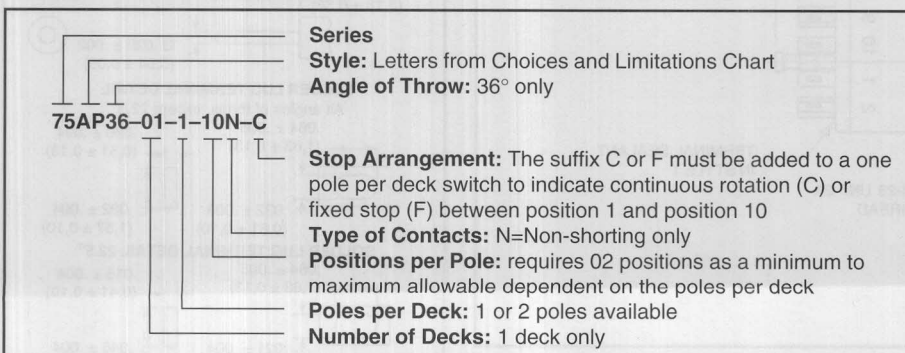
Terminals: Switches are provided with the full circle of terminals regardless of the number of active positions.

Stop Strength: 8 ounce-inches minimum

CHOICES AND LIMITATIONS

Style and Designation		Angle Of Throw	Stops	Terminal	Poles Per Deck	Number of Decks		Number of Positions/Pole
\varnothing 0.187 (4,75) Circle of Term.	\varnothing 0.300 (7,62) Circle of Term.					Shorting	Non-Shorting	
AP = Screwdriver Actuated	AF = Screwdriver Actuated	36°	Fixed	Printed	1 2	Not Available	1 1	2 thru 10 2 thru 5
BP = Shaft Operated	BF = Shaft Operated							
CP = Integral Knob	CF = Integral Knob							

ORDERING INFORMATION



Available from your local Grayhill Distributor

For prices and discounts, contact a Local Sales Office, an authorized local Distributor, or Grayhill.

1/2" DIAMETER, 200 MA ROTARY SWITCHES

SERIES 50 AND 51

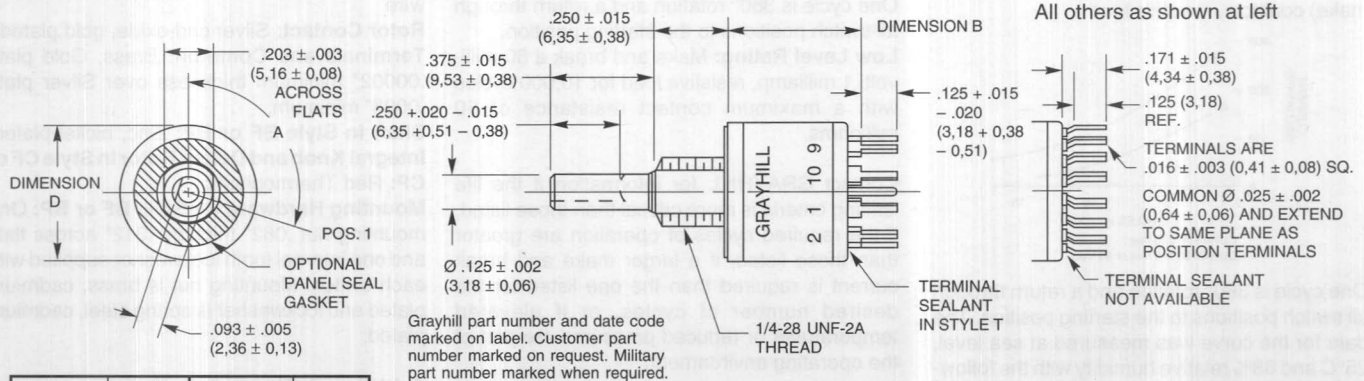
FEATURES

- Optional Complete Seal for PC Board Assembly and Cleaning
- Small 1/2 Inch Diameter
- Choice of 22.5°, 30°, 36°, 45°, 60° and 90° Angles of Throw
- Up to 4 Poles on 1 Deck
- Up to 16 Positions Per Switch
- PC or Solder Lug Termination
- Positive Shaft Grounding for EMI/RFI Shielding
- 1/4" Diameter Shafts—Contact Grayhill for Availability



DIMENSIONS In inches (and millimeters)

PC Mount Style

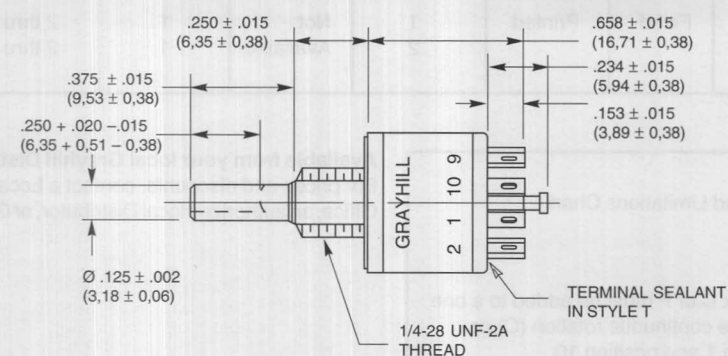


Angle of Throw	Angle A	Angle of Throw	Angle A
22.5°	101.25°	45°	112.5°
30°	105°	60°	120°
36°	108°	90°	135°

Dimension	Series 50	Series 51
D	.500 + .025 - .015 (12,70 + 0,64 - 0,38)	.562 + .025 - .015 (14,27 + 0,64 - 0,38)

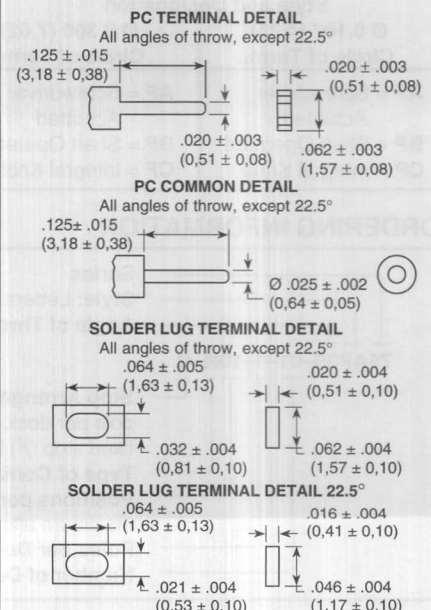
Dimension	Style T	All Others
B	.576 ± .015 (14,63 ± 0,38)	.537 + .020 - .030 (13,64 + 0,51 - 0,76)

Solder Lug Style



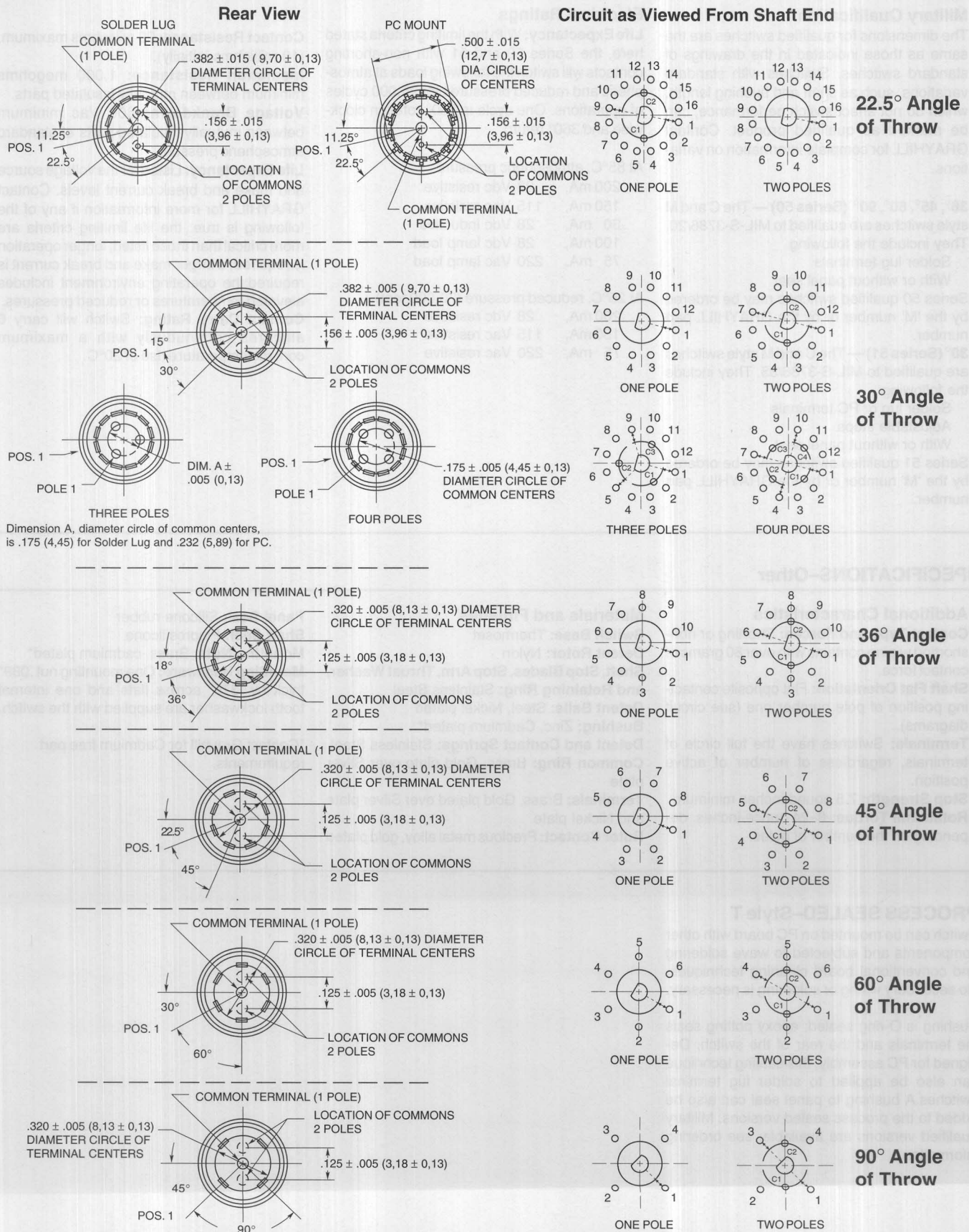
Front view same as PC Mount style.

Terminal Detail



1/2" DIAMETER, 200 MA ROTARY SWITCHES

CIRCUIT DIAGRAMS AND REAR VIEWS FOR SOLDER LUG TERMINALS AND PC MOUNTABLE



1/2" DIAMETER, 200 MA ROTARY SWITCHES

SPECIFICATIONS

Military Qualification

The dimensions for qualified switches are the same as those indicated in the drawings of standard switches. Switches with standard variations, such as shaft and bushing length, which do not affect switch performance, can be marked as qualified product. Contact GRAYHILL for complete information on variations.

36°, 45°, 60°, 90° (Series 50) — The C and M style switches are qualified to MIL-S-3786/20. They include the following:

- Solder lug terminals
- With or without panel seal

Series 50 qualified switches may be ordered by the 'M' number or by the GRAYHILL part number.

30° (Series 51) — The C and M style switches are qualified to MIL-S-3786/35. They include the following:

- Solder lug or PC terminals
- Adjustable stops
- With or without panel seal

Series 51 qualified switches may be ordered by the 'M' number or by the GRAYHILL part number.

Electrical Ratings

Life Expectancy: With the limiting criteria stated here, the Series 50 and 51 with non-shorting contacts will switch the following loads at atmospheric and reduced pressures for 25,000 cycles of operations. One cycle is 360° rotation clockwise and 360° return.

At 85°C, atmospheric pressure	
200 mA,	28 Vdc resistive
150 mA,	115 Vac resistive
30 mA,	28 Vdc inductive
100 mA,	28 Vdc lamp load
75 mA,	220 Vac lamp load

At 25°C, reduced pressure (70,000 feet)

200 mA,	28 Vdc resistive
150 mA,	115 Vac resistive
75 mA,	220 Vac resistive

Contact Resistance: 20 milliohms maximum, (10 milliohms initially).

Insulation Resistance: 1,000 megohms minimum between mutually insulated parts.

Voltage Breakdown: 600 Vac minimum between mutually insulated parts at standard atmospheric pressure.

Life Expectancy: Listed for the voltage source and make and break current levels. Contact GRAYHILL for more information if any of the following is true: the life limiting criteria are more critical than those listed; longer operation is required; a larger make and break current is required; the operating environment includes elevated temperatures or reduced pressures.

Contact Carry Rating: Switch will carry 6 amperes continuously with a maximum contact temperature rise of 20°C.

SPECIFICATIONS—Other

Additional Characteristics

Contact Type and Forces: Shorting or non-shorting wiping contacts with over 80 grams of contact force.

Shaft Flat Orientation: Flat opposite contact position of pole number one (see circuit diagrams).

Terminals: Switches have the full circle of terminals, regardless of number of active position.

Stop Strength: 7.5 pound-inches minimum

Rotational Torque: 8–24 ounce-inches, depending on the number of poles.

Materials and Finishes

Switch Base: Thermoset

Detent Rotor: Nylon

Shaft, Stop Blades, Stop Arm, Thrust Washer, and Retaining Ring: Stainless Steel

Detent Balls: Steel, Nickel plated

Bushing: Zinc, Cadmium plated*

Detent and Contact Springs: Stainless Steel

Common Ring: Brass, Gold plate over Silver plate

Terminals: Brass, Gold plated over Silver plate and Nickel plate

Rotor Contact: Precious metal alloy, gold plated

Panel Seal: Silicone rubber

Shaft Seal: Fluorosilicone

Mounting Nuts: Brass, cadmium plated*

Mounting Hardware: One mounting nut .089" thick by .375" across flats and one internal tooth lockwasher are supplied with the switch.

*Contact Grayhill for Cadmium free part requirements.

PROCESS SEALED—Style T

Switch can be mounted on PC board with other components and subjected to wave soldering and conventional board cleaning techniques. No secondary wiring or soldering is necessary.

Bushing is O-ring sealed; epoxy potting seals the terminals and the rear of the switch. Designed for PC assembly, this sealing technique can also be applied to solder lug terminal switches. A bushing to panel seal can also be added to the process sealed versions. Military qualified versions are available, see ordering information.

1/2" DIAMETER, 200 MA ROTARY SWITCHES

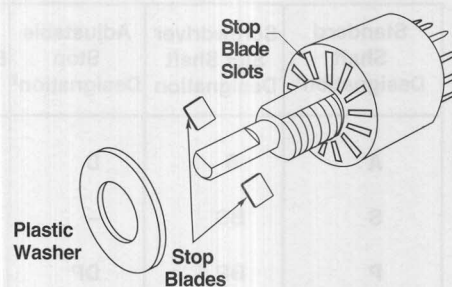
SUGGESTED ADJUSTABLE STOP SUBSTITUTION GUIDE

Fixed Stop Style	Adj. Stop Style Equivalent	Fixed Stop Style	Adj. Stop Style Equivalent
50A	50D	51A	50D
50C	50CD	51C	51CD
50CP	50CDP	51CP	51CDP
50M	50CD*	51M	51CD*
50MP	50CDP*	51MP	51CDP*
50P	50DP	51P	51DP
50S	50D*	51S	51D*
50SP	50DP*	51SP	51DP*

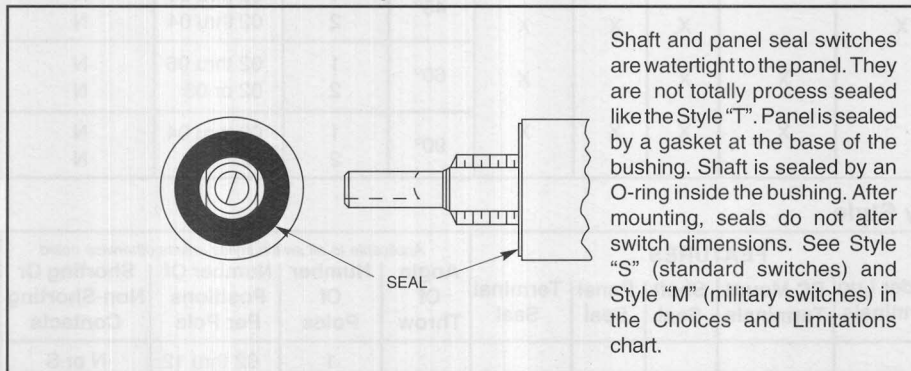
*Form fit and function equivalents, but not watertight sealed to the panel.

ADJUSTABLE STOPS—Style D

Adjustable stops permit the user to set and reset the number of positions per poles. Shown in the diagram, a plastic washer can be removed to reveal slots at the base of the bushing. Stop blades can be inserted into the appropriate slots to limit switch rotation. Positions per pole configuration can thus be changed to meet the needs of the application. Dimensions are the same as the fixed stop version, when plastic washer is in place. Most desirable for prototype work. Readily available from local distributor.

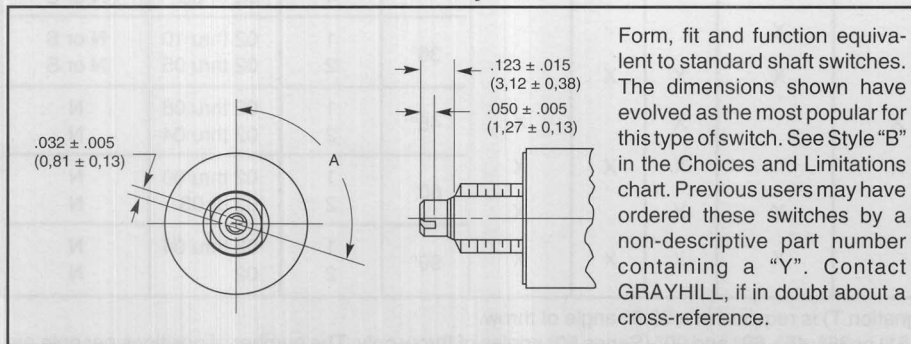


SHAFT AND PANEL SEAL—Styles S and M



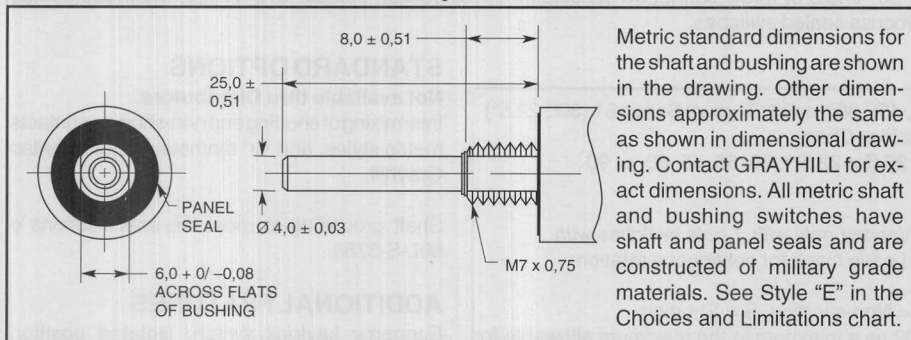
Shaft and panel seal switches are watertight to the panel. They are not totally process sealed like the Style "T". Panel is sealed by a gasket at the base of the bushing. Shaft is sealed by an O-ring inside the bushing. After mounting, seals do not alter switch dimensions. See Style "S" (standard switches) and Style "M" (military switches) in the Choices and Limitations chart.

SCREWDRIVER SLOTTED SHAFT—Style B



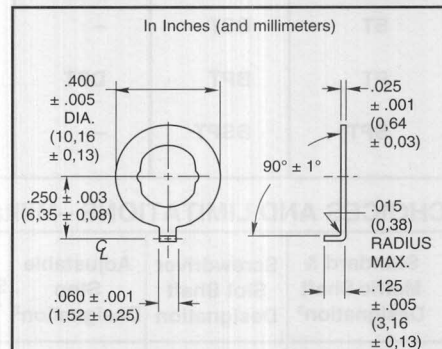
Form, fit and function equivalent to standard shaft switches. The dimensions shown have evolved as the most popular for this type of switch. See Style "B" in the Choices and Limitations chart. Previous users may have ordered these switches by a non-descriptive part number containing a "Y". Contact GRAYHILL, if in doubt about a cross-reference.

METRIC SHAFT AND BUSHING—Style E



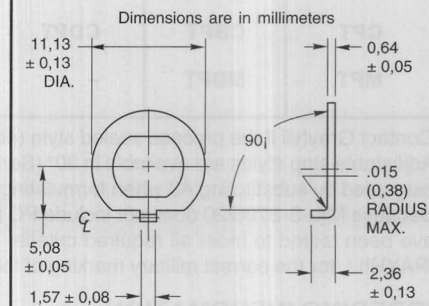
Metric standard dimensions for the shaft and bushing are shown in the drawing. Other dimensions approximately the same as shown in dimensional drawing. Contact GRAYHILL for exact dimensions. All metric shaft and bushing switches have shaft and panel seals and are constructed of military grade materials. See Style "E" in the Choices and Limitations chart.

ACCESSORY—Non-Turn Washers



Part No. 50J1066

Cut round hole for the bushing and for the non-turn tab. Washer fits the double D bushing flats. Washer is sold only when accompanied by an order for a like number of switches. Washer is 302 stainless steel.



Part No. 71J1103

Designed to fit the double flattened bushing of the metric dimensioned bushing, this non-turn washer permits a round hole for the bushing and the tab while still preventing switch rotation. Washer is only sold when accompanied by a like number of switches. Washer is 302 stainless steel.

1/2" DIAMETER, 200 MA ROTARY SWITCHES

CHOICES AND LIMITATIONS –Standard Style

Standard Shaft Designation ¹	Screwdriver Slot Shaft Designation	Adjustable Stop Designation ²	FEATURES					Applicable to all switch styles unless otherwise noted			
			Solder Lug Terminals	PC Mount Terminals	Shaft Seal	Panel Seal	Terminal Seal	Angle Of Throw	Number Of Poles	Number Of Positions Per Pole	Shorting Or Non-Shorting Contacts
A	B	D	X					22.5°	1 2	02 thru 16 02 thru 08	N or S N or S
S	BS	–	X		X	X		30°	1 2 3 4	02 thru 12 02 thru 06 02 thru 04 02 or 03	N or S N or S N or S N or S
P	BP	DP		X							
SP	BSP	–		X	X	X		36°	1 2	02 thru 10 02 thru 05	N or S N or S
AT	BT	DT	X		X		X				
ST	BST	–	X		X	X	X	45°	1 2	02 thru 08 02 thru 04	N N
PT	BPT	DPT		X	X		X	60°	1 2	02 thru 06 02 or 03	N N
SPT	BSPT	–		X	X	X	X	90°	1 2	02 thru 04 02	N N

CHOICES AND LIMITATIONS –Military Style

Standard & Metric Shaft Designation ³	Screwdriver Slot Shaft Designation	Adjustable Stop Designation ²	FEATURES					Applicable to all switch styles unless otherwise noted			
			Solder Lug Terminals	PC Mount Terminals	Shaft Seal	Panel Seal	Terminal Seal	Angle Of Throw	Number Of Poles	Number Of Positions Per Pole	Shorting Or Non-Shorting Contacts
C	CB	CD	X					30°	1 2 3 4	02 thru 12 02 thru 06 02 thru 04 02 or 03	N or S N or S N or S N or S
M	MB	–	X		X	X					
CP	CBP	CDP		X				36°	1 2	02 thru 10 02 thru 05	N or S N or S
MP	MBP	–		X	X	X					
CT	CBT	CDT	X		X		X	45°	1 2	02 thru 08 02 thru 04	N N
MT	MBT	–	X		X	X	X				
CPT	CBPT	CDPT		X	X		X	60°	1 2	02 thru 06 02 or 03	N N
MPT	MBPT	–		X	X	X	X	90°	1 2	02 thru 04 02	N N

¹ Contact Grayhill if the process sealed style (designation T) is required in a 22.5° angle of throw.

² Adjustable stop styles are available in 30° (Series 51) or 36°, 45°, 60° and 90° (Series 50) angles of throw only. The number of positions per pole are designated by substituting AJ when formulating the part number.

³ Because MIL-S-3786/20 does not include PC terminals, military style, 36°, 45°, 60° and 90° angles of throw with PC terminals are not qualified, but have been tested to meet all required criteria. If a 30° angle of throw cannot be substituted in the design, contact GRAYHILL, INC. Also contact GRAYHILL for the correct military marking of the process sealed switches.

ORDERING INFORMATION

	Series: Series 50 (36°, 45°, 60°, or 90° Throw); Series 51 (30°; 22.5°) Style: Letters from Choices Chart Angle of Throw: Use 22 (for 22.5°), 30, 36, 45, 60, or 90
	Stop Arrangement: Needed only with 1 pole switches with maximum positions. Leave blank for continuous rotation; add F for fixed stop. Type of Contacts: N = Non-shorting, S = Shorting Positions Per Pole: 02 as a minimum to the maximum allowable for the angle of throw and the number of poles per the Choices Chart. Use Letters AJ in this location if adjustable stop switch is ordered. Poles per Deck: See chart Number of Decks: 01 only

STANDARD OPTIONS

Not available thru Distributors.

Intermixing of shorting and non-shorting contacts, metric styles, and 1/4" diameter shafts. Contact Grayhill.

Shaft grounding to meet the specifications of MIL-S-3786.

ADDITIONAL FEATURES

Economy keylock switch, isolated position, spring return, and coded switches are available in similar series. See Keylock and Special Function Rotary Switch sections.

Available from your local Grayhill Distributor

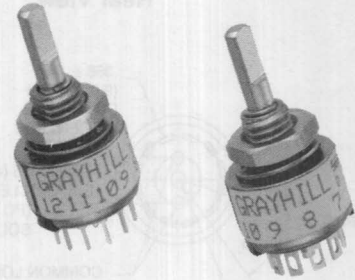
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1/2" DIAMETER, 200 MA ROTARY SWITCHES

SERIES 56

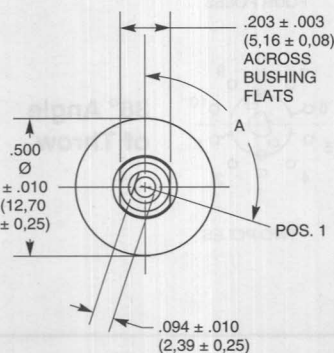
FEATURES

- Requires Minimum Distance Behind the panel
- Adjustable Stop Types Provide Prototypes Immediately
- Industrial Quality, Economically Priced

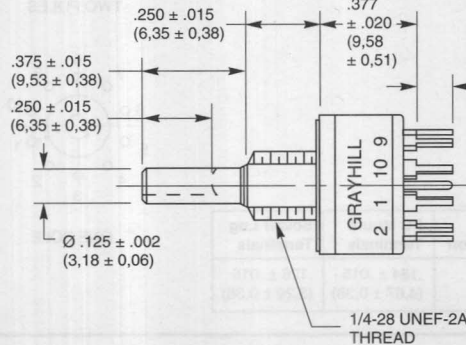


DIMENSIONS In inches (and millimeters)

PC Mount Style

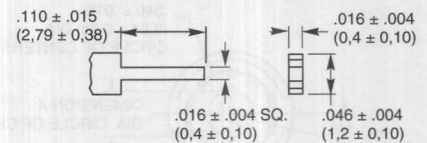


ANGLE OF THROW	ANGLE A
30°	105°
36°	108°

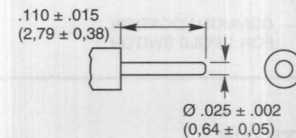


FOR REAR VIEWS, SEE FOLLOWING PAGE.

PC TERMINAL DETAIL

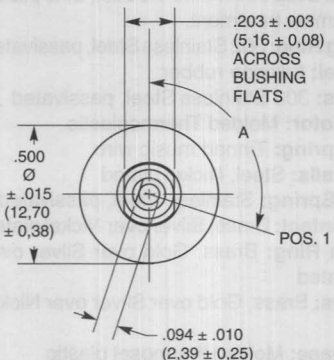


PC COMMON

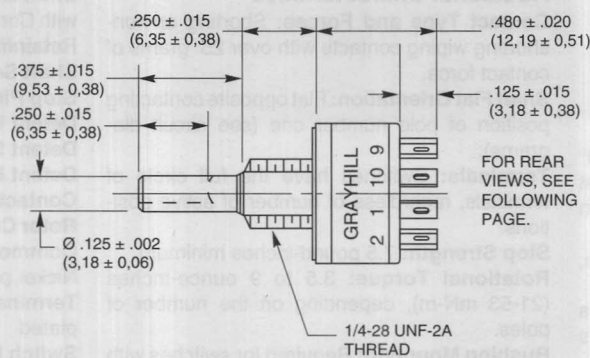


Grayhill part number and date code marked on label.
Customer part number marked on request.

Solder Lug Style

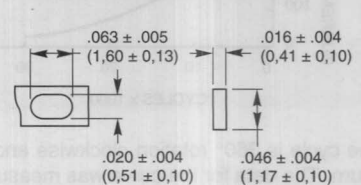


ANGLE OF THROW	ANGLE A
30°	105°
36°	108°

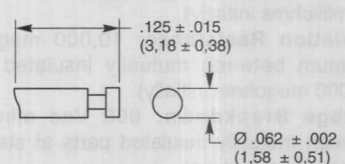


FOR REAR VIEWS, SEE FOLLOWING PAGE.

SOLDER LUG TERMINAL DETAIL



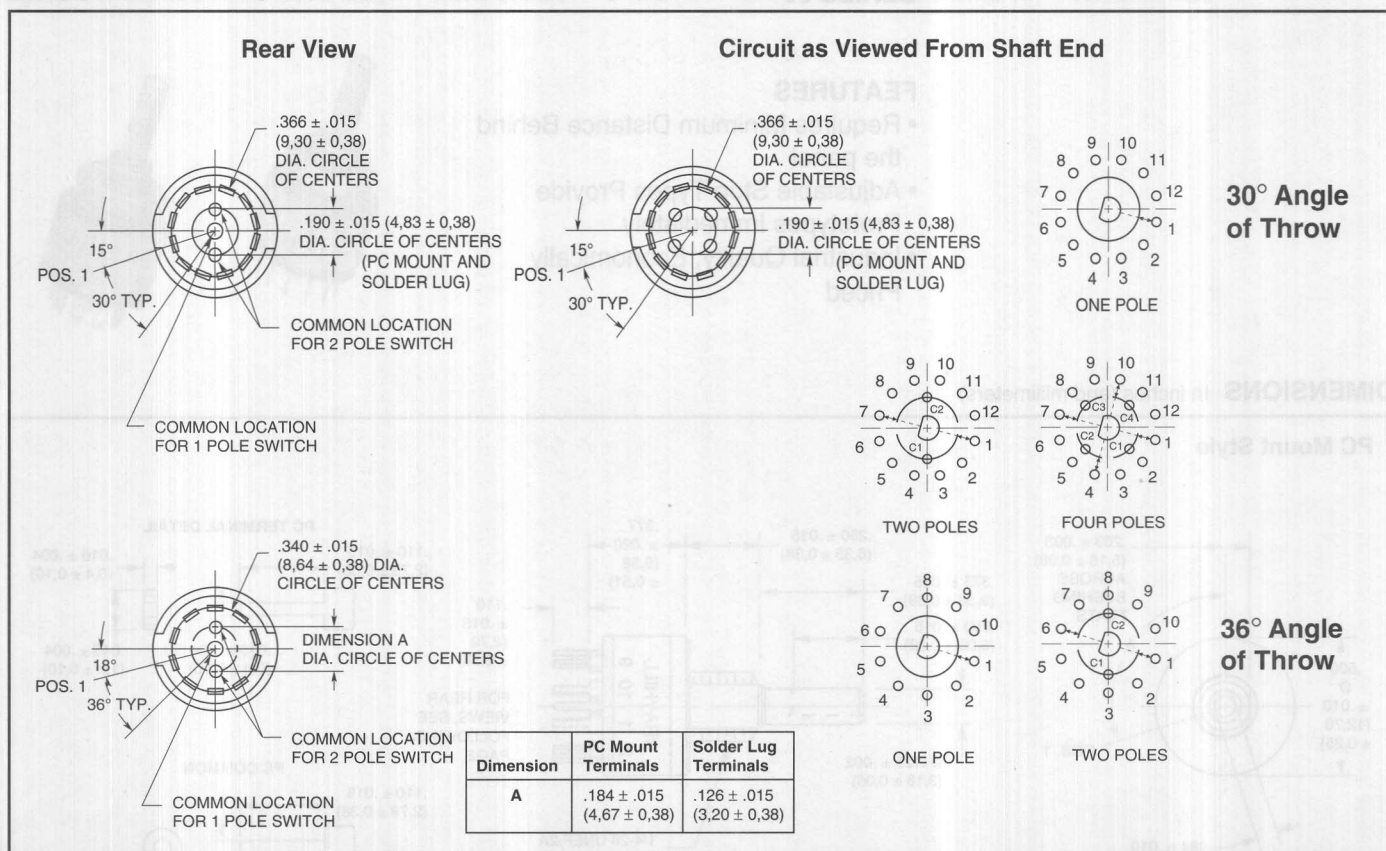
SOLDER LUG COMMON



Grayhill part number and date code marked on label.
Customer part number marked on request.

1/2" DIAMETER, 200 MA ROTARY SWITCHES

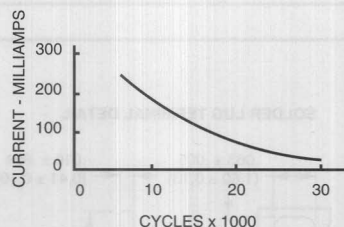
CIRCUIT DIAGRAMS AND REAR VIEWS FOR PC MOUNTABLE AND SOLDER LUG TERMINALS



SPECIFICATIONS

Electrical Ratings

Chart shown for non-shorting (break before make) contacts, resistive load.



One cycle is 360° rotation clockwise and 360° return. The data for the curve was measured at sea level, 25° C and 68% relative humidity with the life limiting criteria which follows.

Contact Resistance: 100 milliohms maximum, (15 milliohms initially).

Insulation Resistance: 10,000 megohms minimum between mutually insulated parts (50,000 megohms initially).

Voltage Breakdown: 600 Vac minimum between mutually insulated parts at standard atmospheric pressure.

Life Expectancy: As determined from the load-life curve for the current to be switched. Contact GRAYHILL for more information if any of the following is true: the life limiting criteria are more critical than those listed; longer operation is

required; a larger make and break current is required; the operating environment includes elevated temperatures or reduced pressures.

Contact Carry Rating: Switch will carry 6 amperes continuously with a maximum contact temperature rise of 20°C.

Additional Characteristics

Contact Type and Forces: Shorting or non-shorting wiping contacts with over 25 grams of contact force.

Shaft Flat Orientation: Flat opposite contacting position of pole number one (see circuit diagrams).

Terminals: Switches have the full circle of terminals, regardless of number of active positions.

Stop Strength: 7.5 pound-inches minimum

Rotational Torque: 3.5 to 9 ounce-inches (21-53 mN-m), depending on the number of poles.

Bushing Mounting: Required for switches with stops, and recommended for switches without stops.

Meets MIL-S-3786 for:

High and medium shock; Vibration (10 to 2,000 Hz); Thermal shock(-65° to 85° C); Salt spray; Explosion; Stop strength (7.5 in-lbs. minimum (.85 N-m); Terminal strength; Sealed styles with-stand water pressure of 15 PSI minimum (103 KPa) without leakage.

Materials and Finishes

Housing: Zinc die cast, Zinc plated with Chromate treatment.

Mounting Nut: Brass, Zinc plated with Chromate treatment.

Lockwasher: Spring Steel, Zinc plated with Chromate treatment.

Panel Seal: Silicone rubber

Shaft and Stop Arm: Zinc die cast, Zinc plated with Chromate treatment.

Retaining Ring: 302 Stainless Steel, passivated

Shaft Seal: Silicone rubber

Stop Pins: 303 Stainless Steel, passivated

Detent Rotor: Molded Thermoplastic

Detent Spring: Tinned music wire

Detent Balls: Steel, Nickel plated

Contact Spring: Stainless Steel, passivated

Rotor Contact: Brass, Silver over Nickel plated

Common Ring: Brass, Gold over Silver over Nickel plated

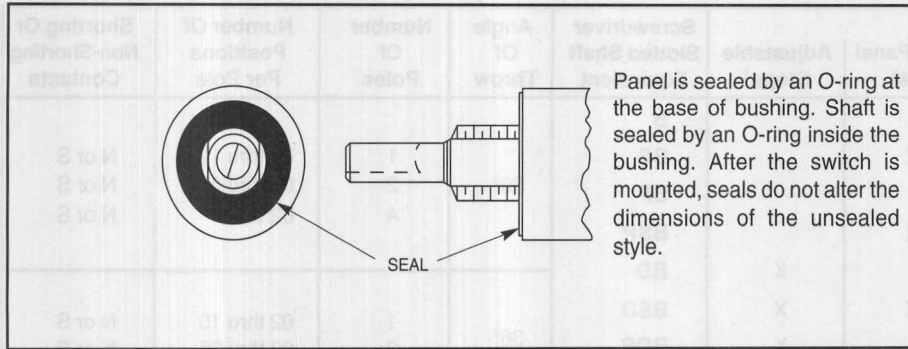
Terminals: Brass, Gold over Silver over Nickel plated

Switch Base: Molded thermoset plastic

Mounting Hardware: One mounting nut .089" thick by .375" across flats and one internal tooth lockwasher are supplied with the switch.

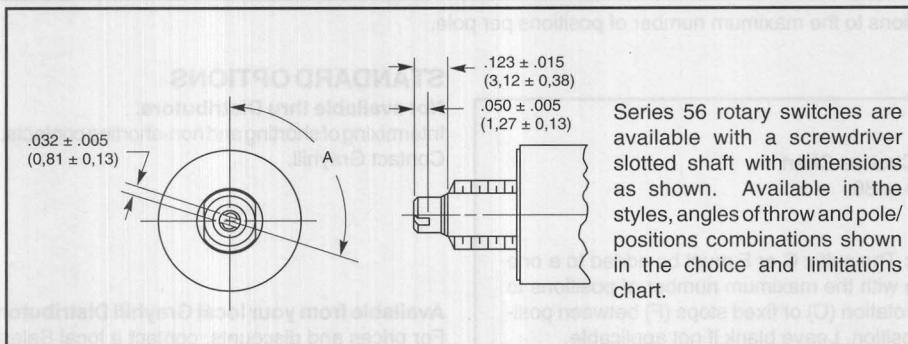
1/2" DIAMETER, 200 MA ROTARY SWITCHES

SHAFT AND PANEL SEAL–Style S



Shaft and Panel Seal

SCREWDRIVER SLOTTED SHAFT–OPTION

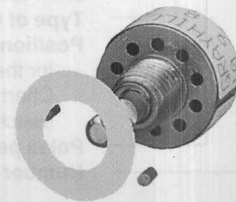
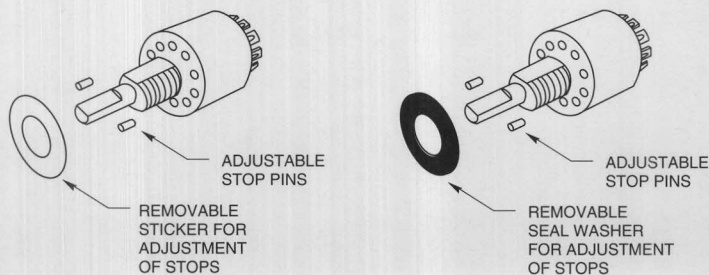


Screwdriver Slotted Shaft

ADJUSTABLE STOP SWITCHES

Two stop pins and an adhesive backed sticker or seal washer are provided. Sticker is temporarily removed to locate stop pins as desired to

limit the shaft rotation. All dimensions are identical to the fixed stop switch counterpart.

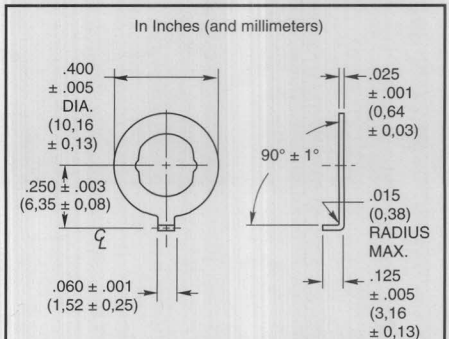


Adjustable Stop

SUGGESTED ADJUSTABLE STOP SUBSTITUTION GUIDE

Fixed Stop Style	Adjustable Stop Style Equivalent	Fixed Stop Style	Adjustable Stop Style Equivalent
56A	56D	56B	56BD
56S	56SD	56BS	56BSD
56P	56DP	56BP	56BDP
56SP	56SDP	56BSP	56BSDP

ACCESSORY–Non-Turn Washer



Part No. 50J1066

Cut round hole for the bushing and for the non-turn tab. Washer fits the double D bushing flats. Washer is sold only when accompanied by an order for a like number of switches. Washer is 302 stainless steel.

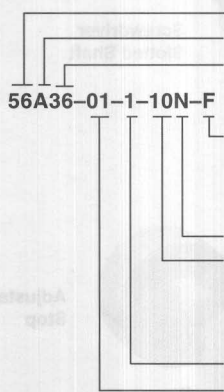
1/2" DIAMETER, 200 MA ROTARY SWITCHES

CHOICES AND LIMITATIONS –Series 56

Style Designation	Solder Lug Terminals	FEATURES			Screwdriver Slotted Shaft Equivalent	Angle Of Throw	Number Of Poles	Number Of Positions Per Pole	Shorting Or Non-Shorting Contacts
		PC Mount Terminals	Shaft/Panel Seal	Adjustable Stops ¹					
A	X				B	30°	1 2 4	02 thru 12 02 thru 06 02 or 03	N or S N or S N or S
S	X		X		BS				
P		X			BP				
SP		X	X		BSP				
D	X			X	BD	36°	1 2	02 thru 10 02 thru 05	N or S N or S
SD	X		X	X	BSD				
DP		X		X	BDP				
SDP		X	X	X	BSDP				

¹ Adjustable stop versions allow selection of 2 positions to the maximum number of positions per pole.

ORDERING INFORMATION



Series
Style: Letters from Choices Chart
Angle of Throw: 30 or 36

Stop Arrangement: The suffix C or F must be added to a one pole per deck switch with the maximum number of positions to indicate continuous rotation (C) or fixed stops (F) between position 1 and the last position. Leave blank if not applicable.

Type of Contacts: N = Non-shorting, S = Shorting

Positions Per Pole: 02 as a minimum to the maximum allowable for the angle of throw and number of poles per the Choices Chart. Use the letters AJ in this location if adjustable stop switch is to be ordered.

Poles per Deck: Limited by angle of throw. See chart

Number of Decks: 01 only

STANDARD OPTIONS

Not available thru Distributors.

Intermixing of shorting and non-shorting contacts. Contact Grayhill.

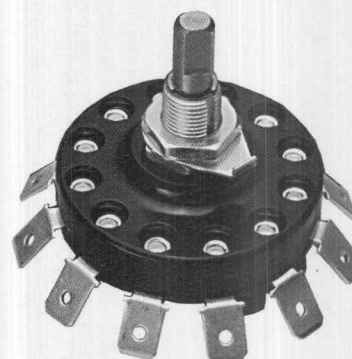
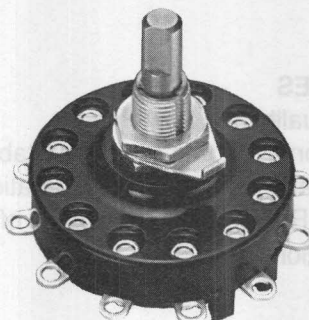
Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 19

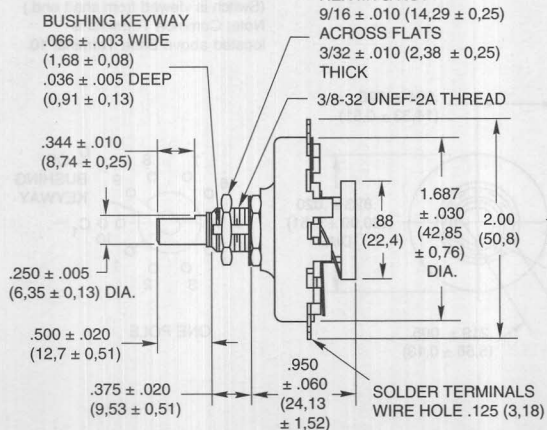
FEATURES

- UL Recognized
- Rugged Construction
- Choice of Termination



DIMENSIONS In inches (and millimeters)

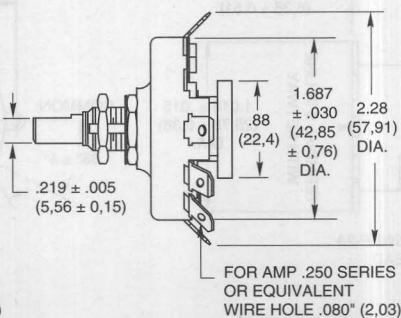
Solder Lug Terminals



Grayhill part number and date code marked on label. Customer part number marked on request.

'Faston' Terminals

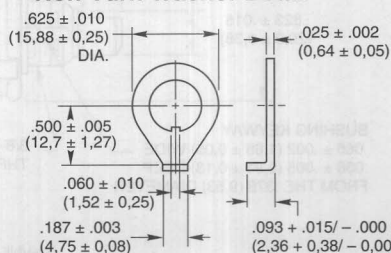
All dimensions not shown are the same as the Solder Lug Terminals.



Circuit Diagram



Non-Turn Washer Detail



SPECIFICATIONS

Electrical Rating

Rated: UL Recognition—File Number E35289
15 Amps, 120 Vac, non-inductive load.
1 Amp, 120 Vdc, non-inductive load.
Additional Grayhill Rating: 7.5 Amps, 220 Vac, non-inductive load.

This rating is based on the following criteria:
Overload—50 operations at 125% rated ac load and 150% rated dc load.

Endurance—6000 operations at rated load with 900 Vac dielectric strength before and after test.
Temperature Rise—Not to exceed 30°C when carrying rated ac load after endurance test.
Contacts will carry 20 Amps at 115 volts ac with 30°C maximum temperature rise.

Contact Resistance: (Measured at 2 Vdc and approximately 100 mA) for new switch approximately 10 milliohms.

Insulation Resistance: Approximately 100,000 megohms. Between mutually insulated parts.

Voltage Breakdown: Approximately 2500 Vac. Between mutually insulated parts.

Materials and Finishes

Rotor Contact: Silver Alloy
Stator Contact: Silver Alloy
Shaft: 303 Stainless Steel
Stop Rivet: Steel, Cadmium plated
Mounting Bushing: Brass, Cadmium plated
Base and Drive Hub: Heat resistant, electrical grade Phenolic.

Detent Mechanism: Brass, Silver plated
"Faston" Terminal: Brass, Silver plated
Solder Terminal: Brass, Silver plated
Mounting Hardware: One mounting nut 9/16" across flats, 3/32" thick and one non-turn washer (see detail) are supplied with each switch.

Additional Characteristics

Single Pole, Single Deck: 2 to 11 positions plus common

30° Indexing.

Contacts: Non-shorting type

Stops: A rivet provides the fixed stop on all switches. Minimum number of positions is 2, and maximum is 11. Terminal 12, the common, is isolated from rotation.

Rotational Torque: 30 to 75 ounce-inches on a new switch. Approximately 22 ounce-inches after 25,000 cycles of operation.

Contact Force: Approximately 12 ounces

ACCESSORIES

Screw Terminal Adapter

Spring loaded, plug-in adapters for 'Faston' Terminals provide excellent mechanical fit and electrical contact. Adapter material is brass tinned. The terminal adapters are available with a 6-32 thread (-1) or 8-32 thread (-2). A 1/4" pan head screw is provided as part of the adapter.

Part No. SC-906-16-32 Thread
Part No. SC-906-28-32 Thread



Non-Turn Washer

Brass, cadmium plated washer, detailed above may be purchased as a separate item.
Part No. 19C1014.

ORDERING INFORMATION

Part Numbers: Designate as follows, using the 2 digits after the dash to indicate the number of positions.

For Faston Terminal:
Use 19101-02UL through 19101-11UL

For Solder Terminal:
Use 19001-02UL through 19001-11UL

Specials: Not available through distributors. For special shafts, bushings, etc. contact GRAYHILL.

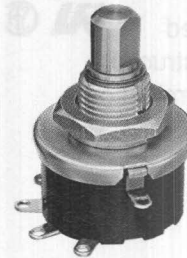
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1" DIAMETER, 1AMP ROTARY SWITCHES

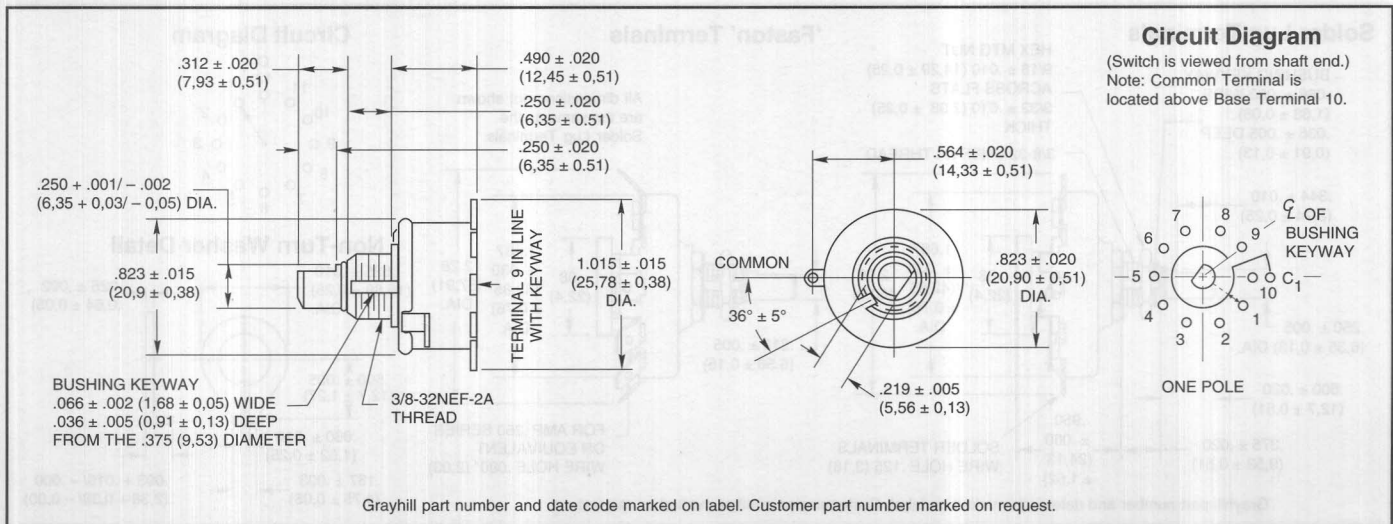
SERIES 5000

FEATURES

- High Quality at a Low Price
- High Contact Force Provides Stable Electrical and Mechanical Operation
- Proven Reliability in Thousands of Applications



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Electrical Rating

Rated: To make and break the following loads: 1 amp at 115 Vac resistive; 0.5 Amp at 220 Vac resistive; 1/4 amp, 115 Vac inductive; 1/50 amp, 115 Vdc inductive; 1/10 amp, 6 to 28 Vdc inductive; 1/10 amp, 115 Vdc resistive; 1 amp, 6 to 28 Vdc resistive; to carry 10 amps continuously.

Contact Resistance: 10 milliohms initial. After 25,000 cycles of operation 20 milliohms maximum.

Insulation Resistance: 50,000 megohms minimum initially

Voltage Breakdown: 1,000 Vac (500 Vac, or better after most environmental tests).

Life Expectancy: 100,000 mechanical cycles of operation normally.

NOTE: Actual life is determined by a number of factors, including electrical loading, rate of rotation, and environment, as well as maximum contact resistance, minimum insulation resistance, and minimum voltage breakdown required at the end of life.

Materials and Finishes

Switch Bases: Melamine per MIL-M-14

Cover, Stop Washers, Bushing and Nut: Brass, Cadmium plated

Retaining Rings, Stop Arms, and Thrust Washers:

Stainless Steel, passivated

Shaft: Stainless Steel, passivated

Terminals (except common): Brass, Lead-Tin plated, and fused

Rotor Contact: Phosphor Bronze, Silver plated .0003" minimum

Stator (Base) Contact: Brass, Silver plated .0003" minimum

Common Plate: Brass, Silver plated .0003" minimum

Rotor Mounting Plate: Nylon fabric based laminated Phenolic per MIL-T-1 5047.

Additional Characteristics

Stop Strength: 12 pound-inches

Rotational Torque: 12 ounce-inches

Contacts: Shorting or non-shorting wiping contacts with over 500 grams contact force.

Shaft Flat Orientation: Opposite point of contact (See circuit diagram.)

Environmental: These switches have passed the following environmental testing: Altitude and temperature; 100 hour salt spray; Vibration 10 to 500 cps; Shock 30-G; Humidity; Fungus.

Detent: A formed spring operating against a formed wave washer.

STANDARD OPTIONS

Special Terminals

Not available through distributors. See page F-9

ORDERING INFORMATION

The Series 5000 switches are single deck, one pole switches of two to 10 positions. Ten position switches have continuous rotation. Ten position fixed stop switches are available by special order.

The part number is 05001-XX with the number of positions required (02,03, etc.) listed in place of the XX. Complete part number by adding N for non-shortening contacts or S for shortening contacts.

Available from your local Grayhill Distributor

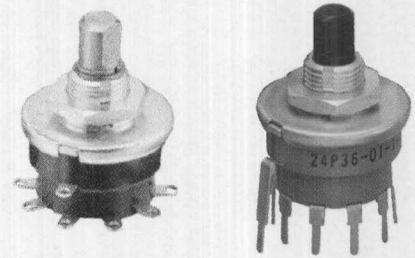
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

1" DIAMETER, 1AMP ROTARY SWITCHES

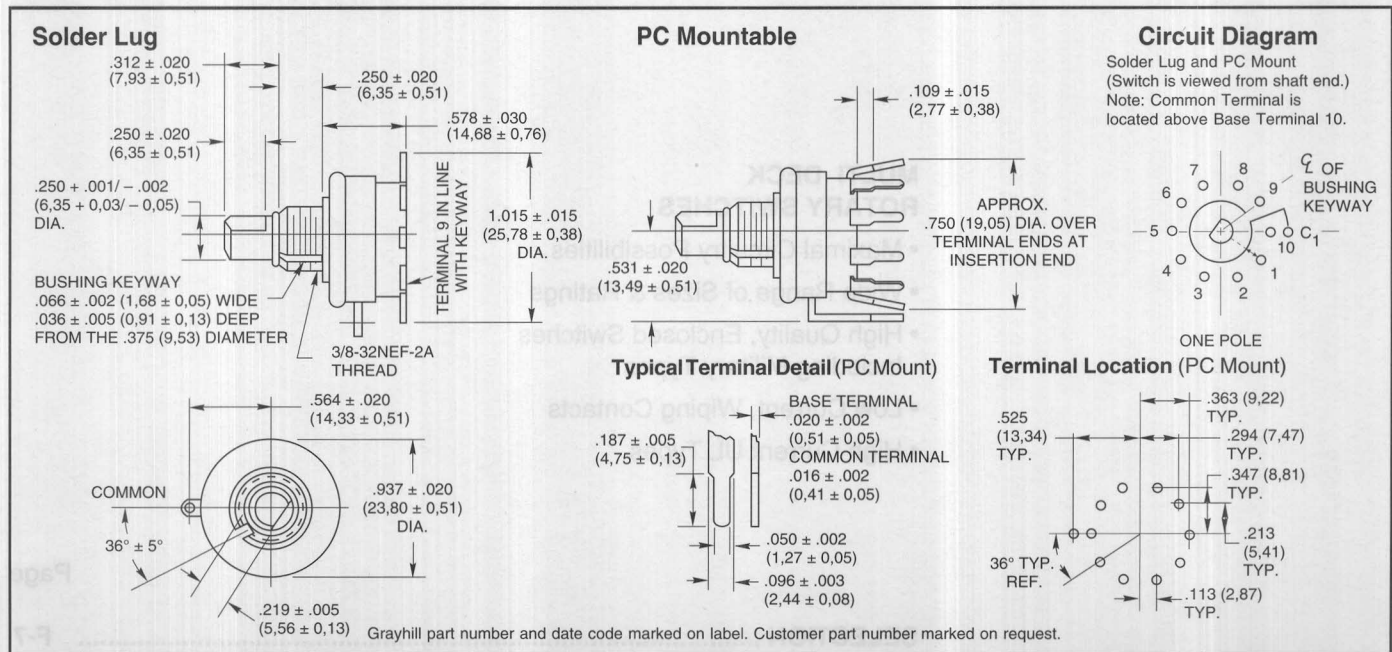
SERIES 24

FEATURES

- Positive Detent Provides Operator Feedback
- Stainless Steel or Plastic Shaft Option
- Unsurpassed Performance in Numerous Applications



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Electrical Rating

Rated: To make and break the following loads: 1 amp at 115 Vac, resistive; 0.5 Amp at 220 Vac resistive; 1/4 amp, 115 Vac inductive; 1/50 amp, 115 Vdc inductive; 1/10 amp, 6 to 28 Vdc inductive; 1/10 amp, 115 Vdc resistive; 1 amp, 6 to 28 Vdc resistive; to carry 10 amps continuously.

Contact Resistance: 10 milliohms initial. After 25,000 cycles of operation 20 milliohms maximum.

Insulation Resistance: 50,000 megohms minimum initially

Voltage Breakdown: 1,000 Vac, (500 Vac, or better after most environmental tests).

Life Expectancy: 100,000 mechanical cycles of operation normally.

NOTE: Actual life is determined by a number of factors, including electrical loading, rate of rotation, and environment, as well as maximum contact resistance, minimum insulation resistance, and minimum voltage breakdown required at the end of life.

Materials and Finishes

Switch Bases: Melamine per MIL-M-14

Cover, Stop Washers, Bushing and Nut: Brass, Cadmium plated

Retaining Rings, Stop Arms, and Thrust Washers: Stainless Steel, passivated

Detent Balls: Steel, Nickel plated

Shafts: Stainless Steel, passivated or Plastic

Detent Springs: Tinned Music Wire

Terminals (except common): Brass, Lead-Tin plated, and fused.

Rotor Contact: Steel Shaft Version—Phosphor Bronze, Silver plated .0003" minimum. Plastic Shaft version—Silver alloy.

Stator (Base) Contact: Brass, Silver plated .0003" minimum

Common Plate, including Solder Lug or PC Tab: Brass, Silver plated .0003" minimum

Rotor Mounting Plate: Nylon fabric based laminated Phenolic per MIL-T-15047

Additional Characteristics

Stop Strength: 12 pound-inches

Rotational Torque: 12 ounce-inches

Contacts: Both shorting and non-shorting wiping contacts have over 300 grams contact force.

Shaft Flat Orientation: Opposite point of contact (See circuit diagram.)

Environmental: These switches have passed the following environmental testing: Altitude and temperature, 100 hour salt spray; Vibration 10 to 500 cps; Shock 30-G; Humidity; Fungus.

PC Mount: PC Switches are furnished with 10 base terminals for mounting purposes.

Detent: Opposing spring and ball in a hill and valley raceway.

STANDARD OPTIONS

Special Terminals

RFI Grounding

Not available through distributors. See page F-9

ORDERING INFORMATION

Switches are single deck, one pole switches of 2 to 10 positions. They have plastic or steel shaft, with solder lug or PC terminals, with either shorting or non-shorting contacts (plastic shaft PC mount in non-shorting only). Ten position switches have continuous rotation; fixed stop switch with a metal shaft is available by special order. Base part numbers are as follows:

Lug style, steel shaft: 24001-X*

Lug style, plastic shaft: 24B36-01-1-X*

PC style, steel shaft: 24878-X*

PC style, plastic shaft: 24P36-01-1-X*

The X is replaced with the number of positions required (02, 03, etc.) Complete the part number by adding N for non-shorting contacts or S for shorting contacts.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.



MULTI DECK ROTARY SWITCHES

- Maximal Circuitry Possibilities
- Wide Range of Sizes & Ratings
- High Quality, Enclosed Switches Including Military Types
- Low Current, Wiping Contacts
- High Current UL Types

SELECTION F-7

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

Standard, Military SR39, Metric, PC	Series 71	F-29
Process Sealed Switch	Series 71	F-34
Concentric Shaft Switches	Series 71	F-35
Adjustable Stop, Shaft/Panel Seal, Accessories	Series 71	F-39
Choices Chart	Series 71	F-41

1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

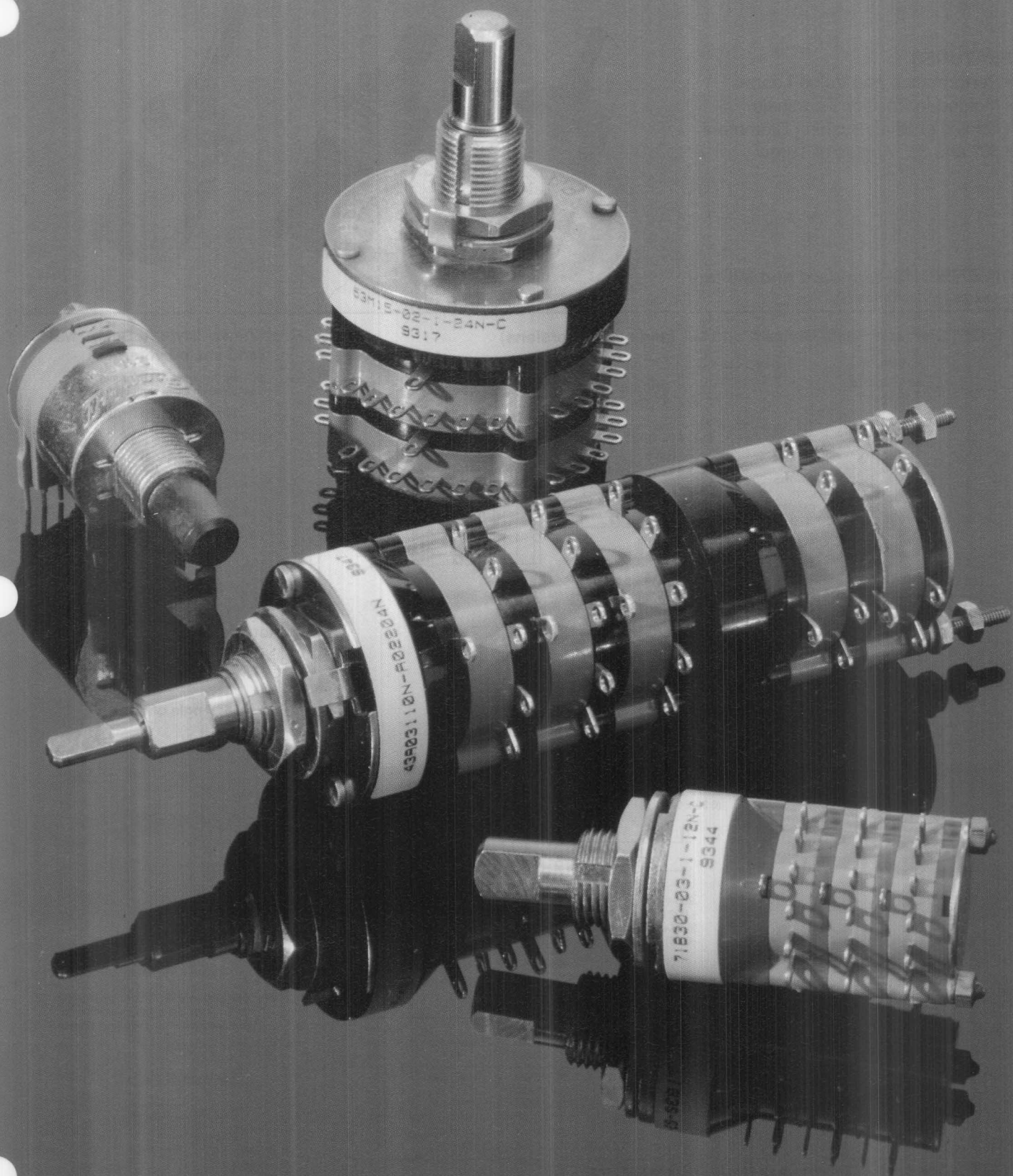
Standard, Military SR13	Series 8 & 9	F-43
PC Mount	Series 8 & 9	F-47
Choices Chart	Series 8 & 9	F-48

1" DIAMETER, 1 AMP ROTARY SWITCHES

Standard, Military SR04, UL	Series 42 & 44	F-49
Concentric Shaft, Add-A-Pot	Series 43 & 54	F-52
Choices Chart	Series 42, 43, 44, 54	F-57
Accessories	Series 8, 12, 42	F-58

16, 20, AND 24 POSITION SWITCHES

Military Qualified SR36	Series 53, 57, 59	F-59
Choices Chart	Series 53, 57, 59	F-62

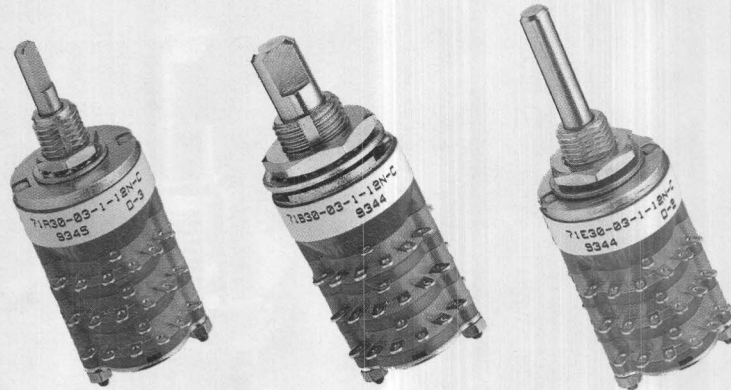


ECONOMICAL, 1/4 AMP ROTARY SWITCHES

SERIES 71

FEATURES

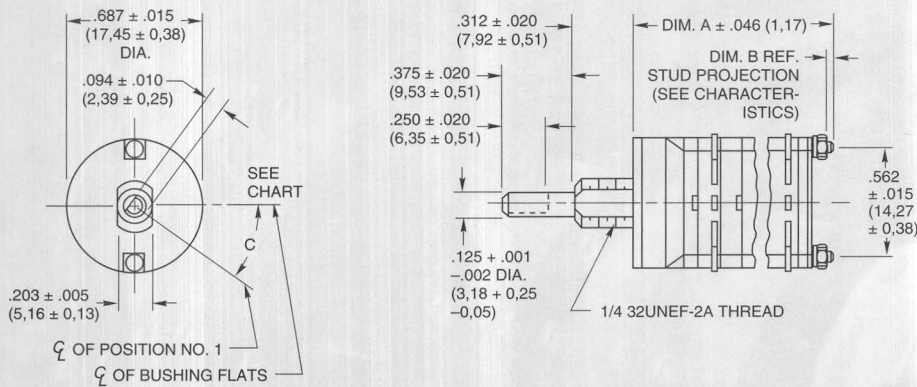
- Performance and Value Leader
- Molded-In Position Terminals
- Choice of Shaft/Bushing Diameters
- 30° and 36° Angles of Throw



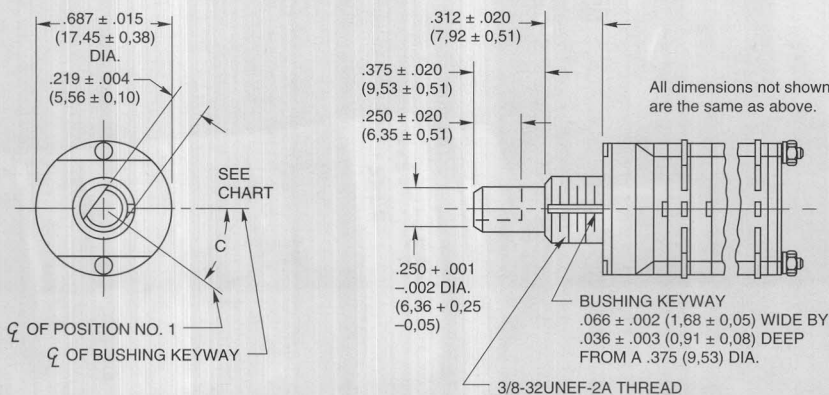
DIMENSIONS—Standard and Military

In inches (and millimeters)

0.125" Diameter Shaft—Styles A and MA (and sealed versions)



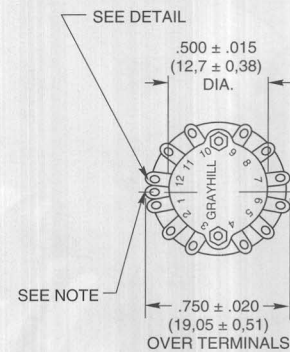
0.250" Diameter Shaft—Styles B and MB (and sealed versions)



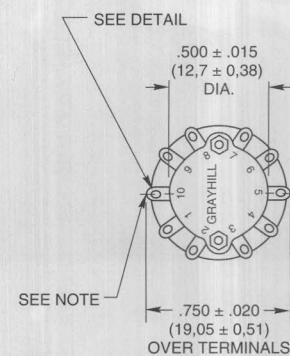
Rear Views—Style A, B, MA, MB (and sealed versions)

30° and 36° Angle of Throw may be interposed on either shaft diameter.

30° Angle of Throw

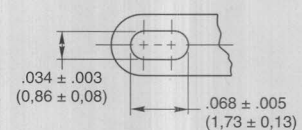


36° Angle of Throw



Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

Terminal Detail



No. of Decks	Dimension A	Dimension B	Approx. Weight Grams	No. of Decks	Dimension A	Dimension B	Approx. Weight Grams
1	.761 (19,33)	.031 (0,79)	14	7	2.349 (59,66)	.312 (7,92)	26
2	.979 (24,87)	.031 (0,79)	16	8	2.567 (65,20)	.312 (7,92)	28
3	1.197 (30,40)	.031 (0,79)	18	9	2.785 (70,74)	.312 (7,92)	30
4	1.415 (35,94)	.031 (0,79)	20	10	3.003 (76,28)	.312 (7,92)	32
5	1.633 (41,48)	.031 (0,79)	22	11	3.221 (81,81)	.312 (7,92)	34
6	2.131 (54,13)	.312 (7,92)	24	12	3.439 (87,35)	.312 (7,92)	36

Angle C is 15° in 12 position switches and 36° in 10 position switches.

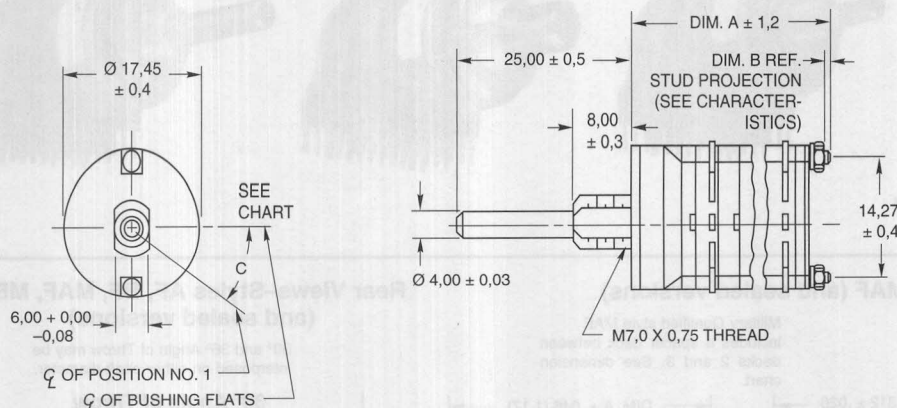
Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

See pages F-37 through F-42 for specifications, accessories and ordering information.

DIMENSIONS—Metric

All dimensions are in millimeters

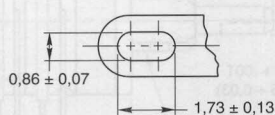
4 mm Diameter Shaft—Style E and ES



No. of Decks	Dim. A	Dim. B	Approx. Weight Grams
1	19,33	0,79	12
2	24,87	0,79	14
3	30,40	0,79	16
4	35,94	0,79	18
5	41,48	0,79	20
6	54,13	7,92	22
7	59,66	7,92	24
8	65,20	7,92	26
9	70,74	7,92	28
10	76,28	7,92	30
11	81,81	7,92	32
12	87,35	7,92	34

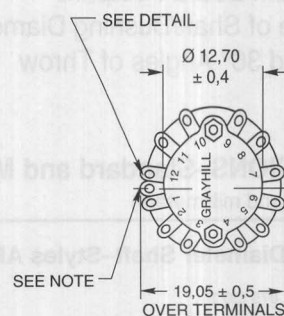
Angle C is 15° in 12 position switches and 36° in 10 position switches.

Terminal Detail

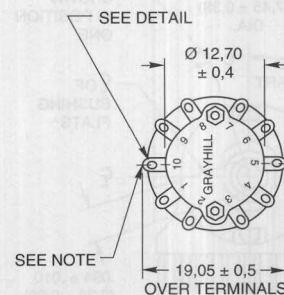


Rear Views

30° Angle of Throw



36° Angle of Throw



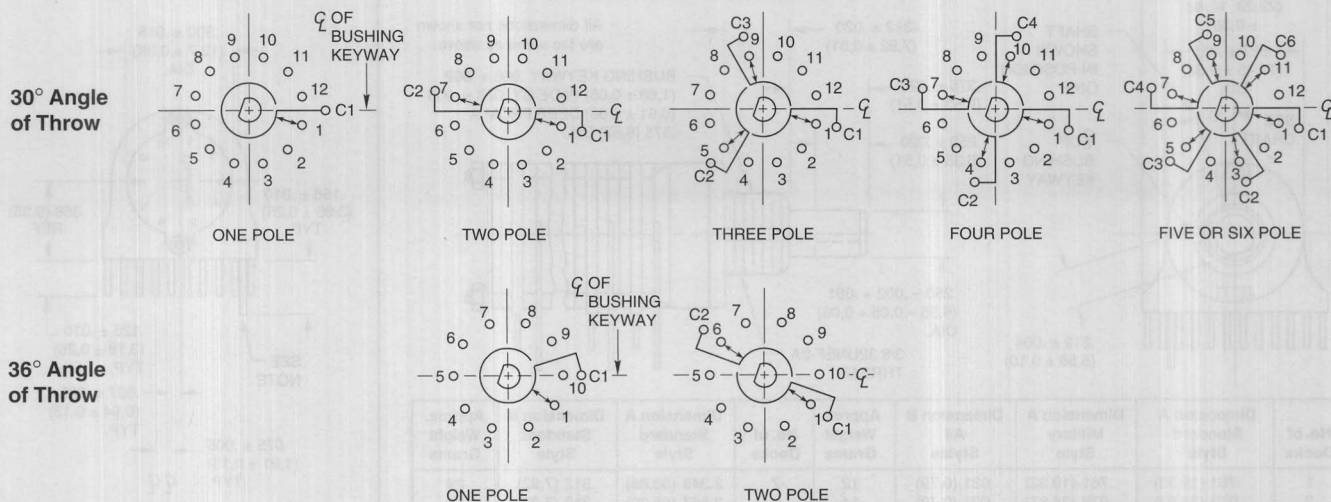
Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request.

CIRCUIT DIAGRAMS—Standard, Military and Metric

Switch is Viewed From Shaft End and Shown in Position No. 1.

Note: All common terminals are located above base terminals as shown.



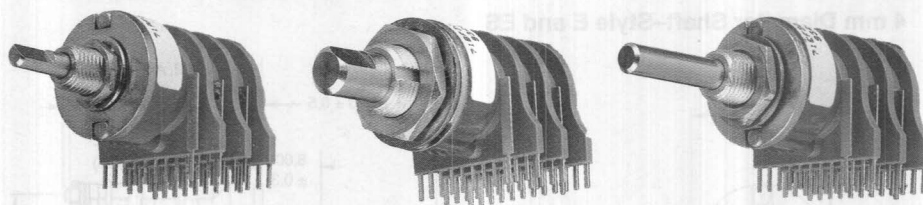
See pages F-37 through F-42 for specifications, accessories and ordering information.

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

SERIES 71-PC MOUNT

FEATURES

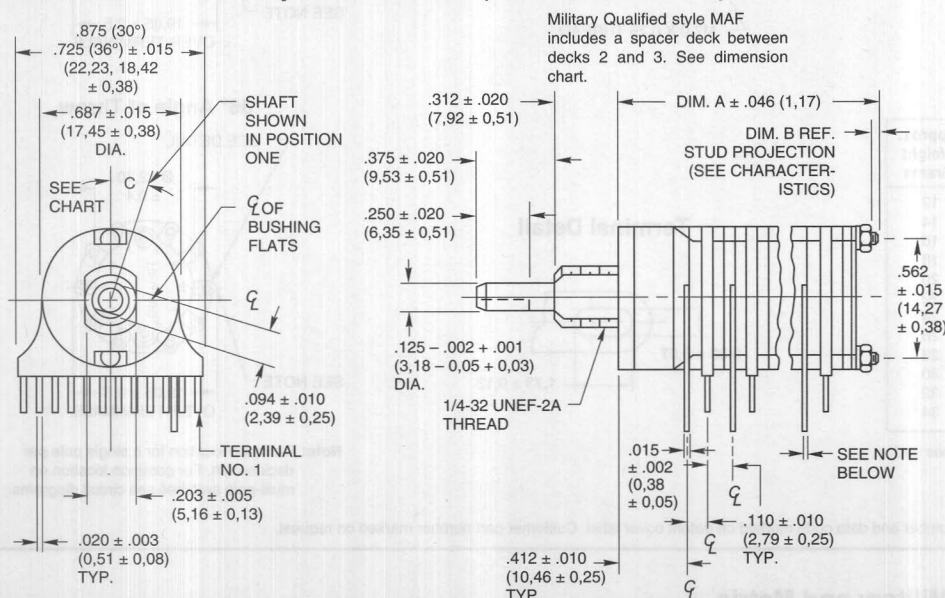
- Terminals From One Side
- Minimum Board Footprint
- Choice of Shaft/Bushing Diameters
- 30° and 36° Angles of Throw



DIMENSIONS—Standard and Military

In inches (and millimeters)

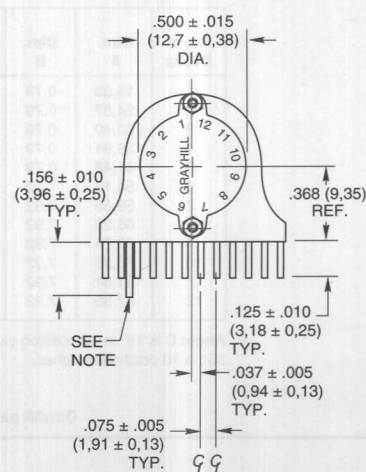
0.125" Diameter Shaft—Styles AF and MAF (and sealed versions)



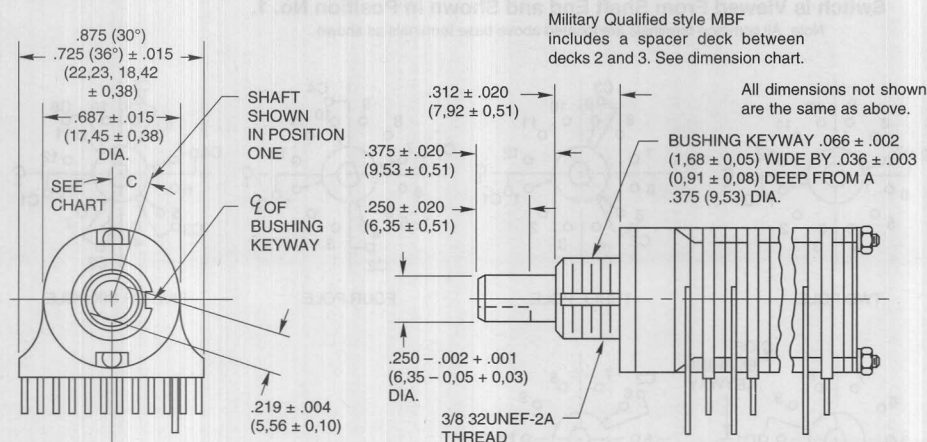
Rear Views—Styles AF, BF, MAF, MBF (and sealed versions)

30° and 36° Angle of Throw may be interposed on either shaft diameter.

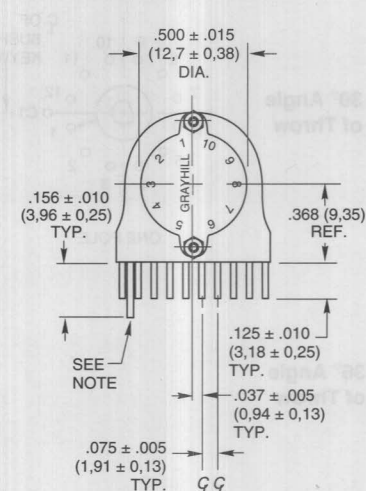
30° Angle of Throw



0.250" Diameter Shaft—Styles BF and MBF (and sealed versions)



36° Angle of Throw



No. of Decks	Dimension A Standard Style	Dimension A Military Style	Dimension B All Styles	Approx. Weight Grams	No. of Decks	Dimension A Standard Style	Dimension B Standard Style	Approx. Weight Grams
1	.761 (19.33)	.761 (19.33)	.031 (0.79)	12	7	2.349 (59.66)	.312 (7.92)	24
2	.979 (24.87)	.979 (24.87)	.031 (0.79)	14	8	2.567 (65.20)	.312 (7.92)	26
3	1.197 (30.40)	1.415 (35.94)	.031 (0.79)	16*	9	2.785 (70.74)	.312 (7.92)	28
4	1.415 (35.94)	1.633 (41.49)	.031 (0.79)	18*	10	3.003 (76.28)	.312 (7.92)	30
5	1.633 (41.48)	N.A.	.031 (0.79)	20	11	3.221 (81.81)	.312 (7.92)	32
6	2.131 (54.13)	N.A.	.312 (7.92)	22	12	3.439 (87.35)	.312 (7.92)	34

Angle C is 15° in 12 position switches and 18° in 10 position switches.
*Military style switch is 18 grams for 3 decks and 20 grams for 4 decks.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

Note: Common location for a single pole per deck switch. For common location on two pole switches see circuit diagrams.

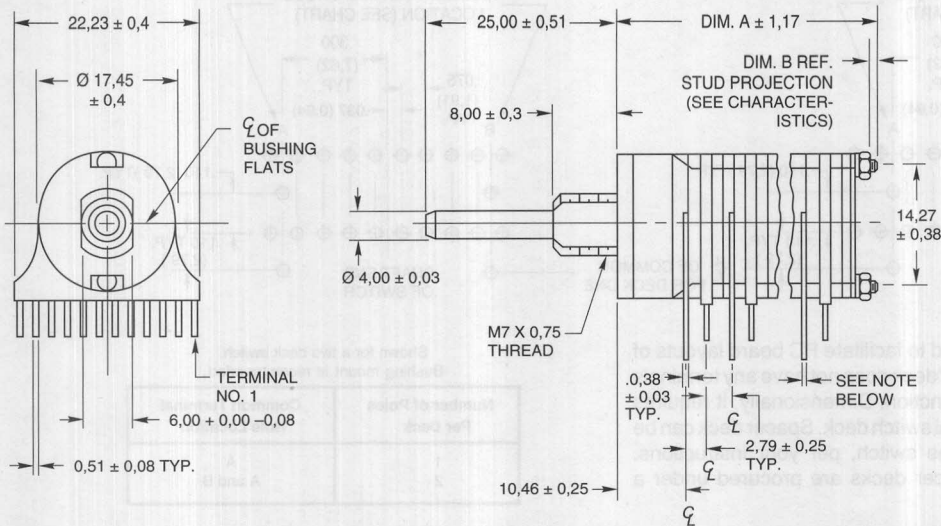
See pages F-37 through F-42 for specifications, accessories and ordering information.

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

DIMENSIONS—Metric

All dimensions are in millimeters.

4 mm Diameter Shaft—Style EF and ESF



No. of Decks	Dim. A	Dim. B	Approx. Weight Grams	No. of Decks	Dim. A	Dim. B	Approx. Weight Grams
1	19,33	0,79	12	7	59,66	7,92	24
2	24,87	0,79	14	8	65,20	7,92	26
3	30,40	0,79	16	9	70,74	7,92	28
4	35,94	0,79	18	10	76,28	7,92	30
5	41,48	0,79	20	11	81,81	7,92	32
6	54,13	7,92	22	12	87,35	7,92	34

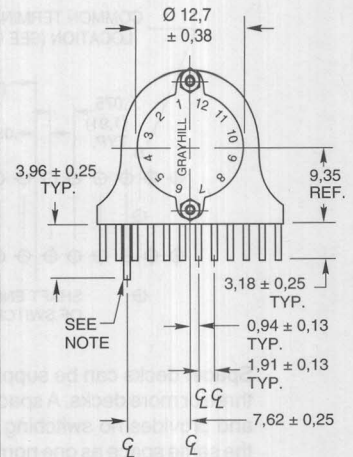
Note: Common location for a single pole per deck switch. For common location on two pole switches see circuit diagrams.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request.

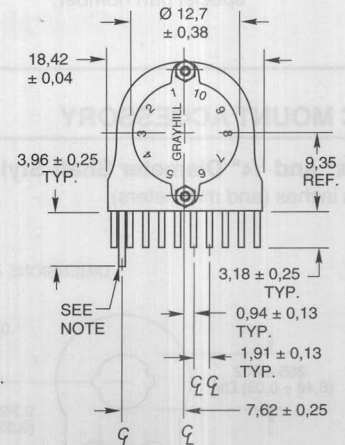
Rear Views

30° and 36° Angle of Throw may be interposed on either shaft diameter.

30° Angle of Throw

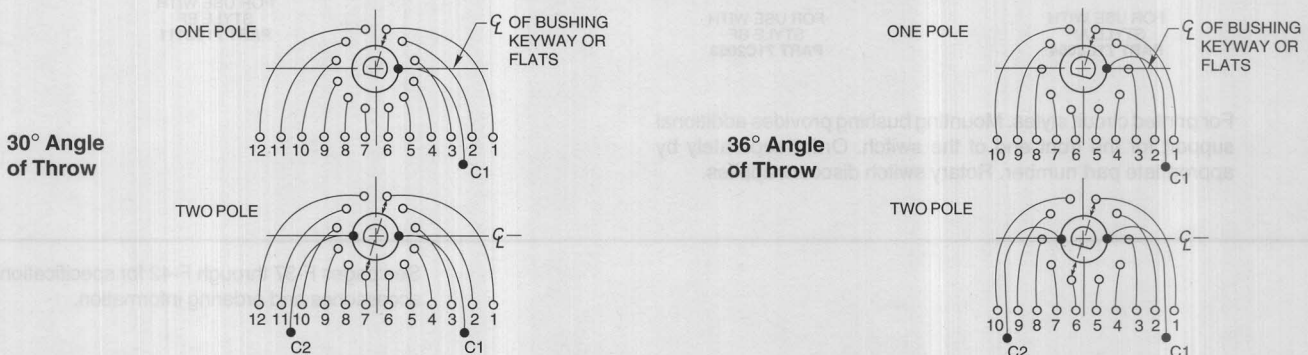


36° Angle of Throw



CIRCUIT DIAGRAMS—Standard, Military and Metric PC Mount

Circuit is Viewed From Shaft End and Shown in Position No. 1



See pages F-37 through F-42 for specifications, accessories and ordering information.

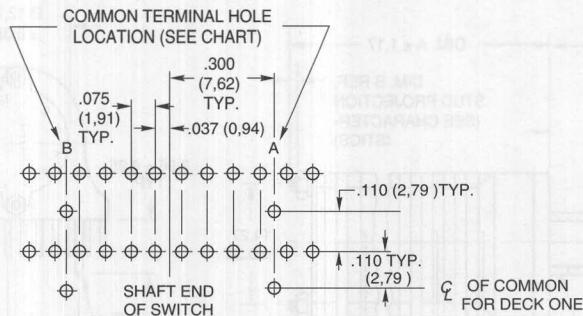
ECONOMICAL, 1/4 AMP ROTARY SWITCHES

SERIES 71-PC BOARD PATTERN

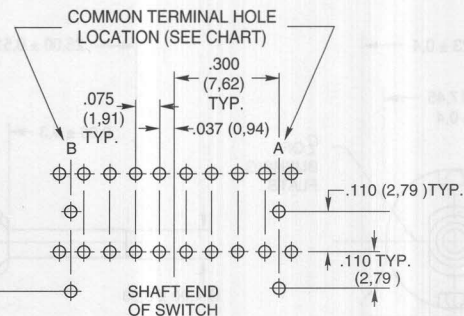
In inches (and millimeters)

All Styles Except 71BT

30° Angle of Throw



36° Angle of Throw



Spacer decks can be supplied to facilitate PC board layouts of three or more decks. A spacer deck does not have any terminals and provides no switching function. Dimensionally, it requires the same space as one normal switch deck. Spacer deck can be placed at any location in the switch, per your instructions. Switches which include spacer decks are procured under a special part number.

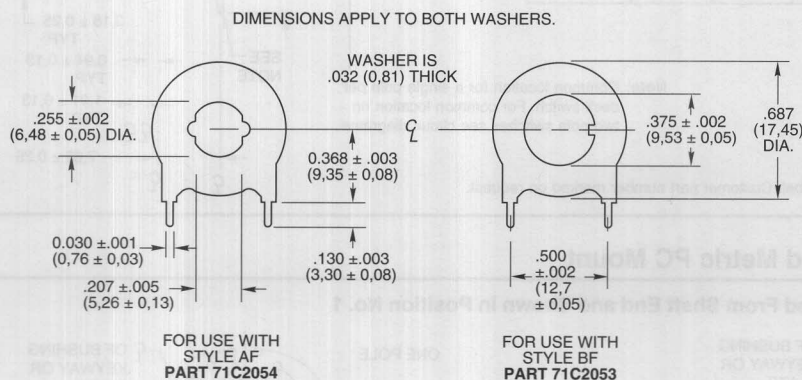
Shown for a two deck switch.
Bushing mount is recommended.

Number of Poles Per Deck	Common Terminal Hole Location
1	A
2	A and B

PC MOUNT ACCESSORY

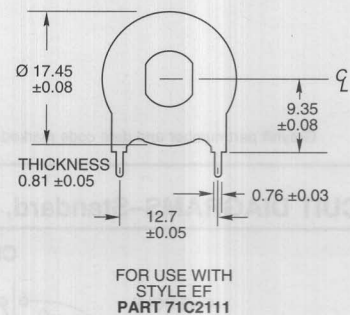
1/8" and 1/4" Diameter Shaft Styles

In inches (and millimeters)



Metric Mount Styles

In Millimeters



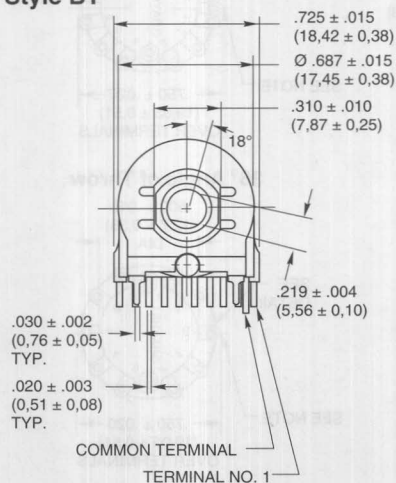
For printed circuit styles. Mounting bushing provides additional support for the front end of the switch. Order separately by appropriate part number. Rotary switch discount applies.

See pages F-37 through F-42 for specifications, accessories and ordering information.

DIMENSIONS—Standard and Military

In inches (and millimeters)

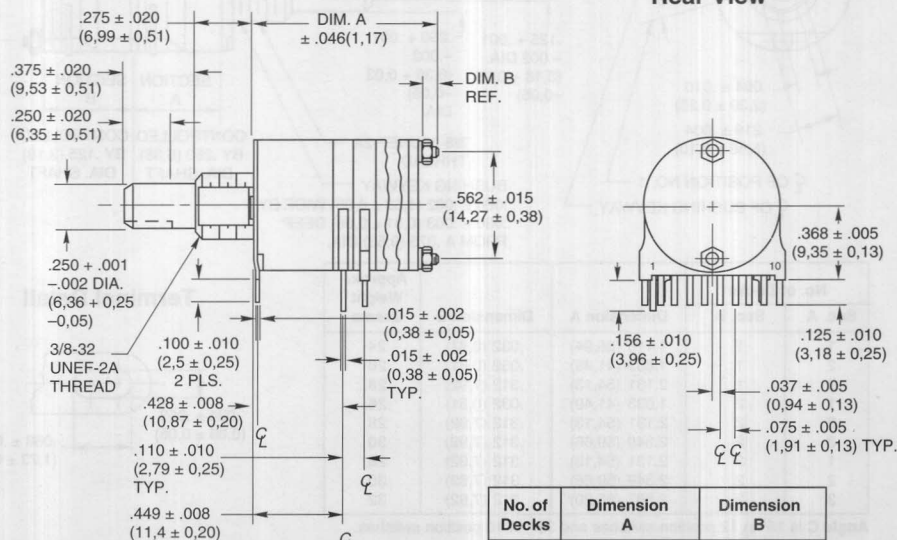
Style BT



Shaft flat is opposite point of contact for pole number one. Shaft is shown here in position 1.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request.

Rear View

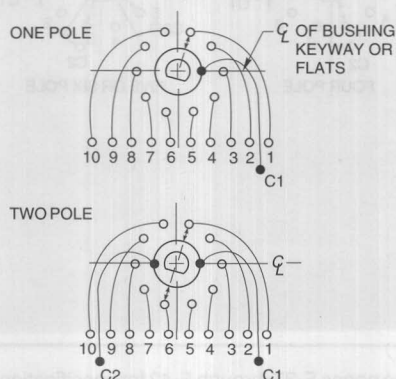


No. of Decks	Dimension A	Dimension B
1	0.795 (20,19)	0.031 (0,79)
2	1.040 (26,42)	0.053 (1,35)
3	1.285 (32,64)	0.076 (1,93)
4	1.530 (38,86)	0.098 (2,49)
5	1.775 (45,09)	0.120 (3,05)

CIRCUIT DIAGRAMS

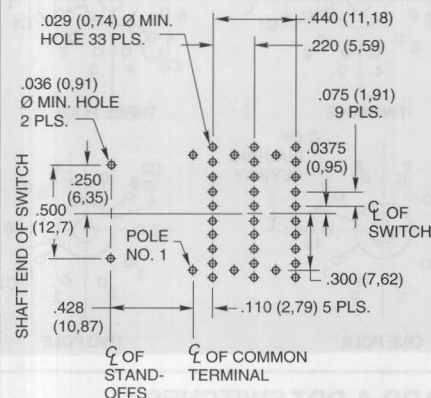
Circuit is Viewed From Shaft End and Shown in Position No. 1

36° Angle of Throw



STYLE 71BT PC BOARD PATTERN

Including Integral Front Plate Standoffs



ECONOMICAL, 1/4 AMP ROTARY SWITCHES

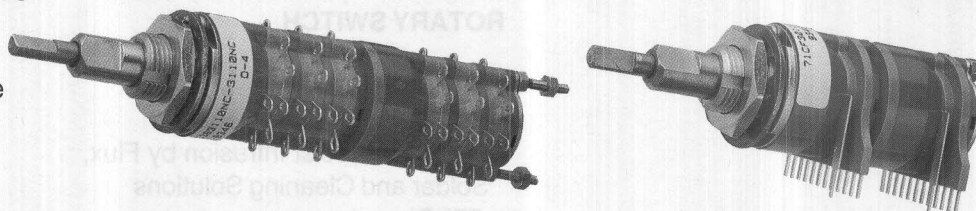
SERIES 71—CONCENTRIC SHAFTS

FEATURES

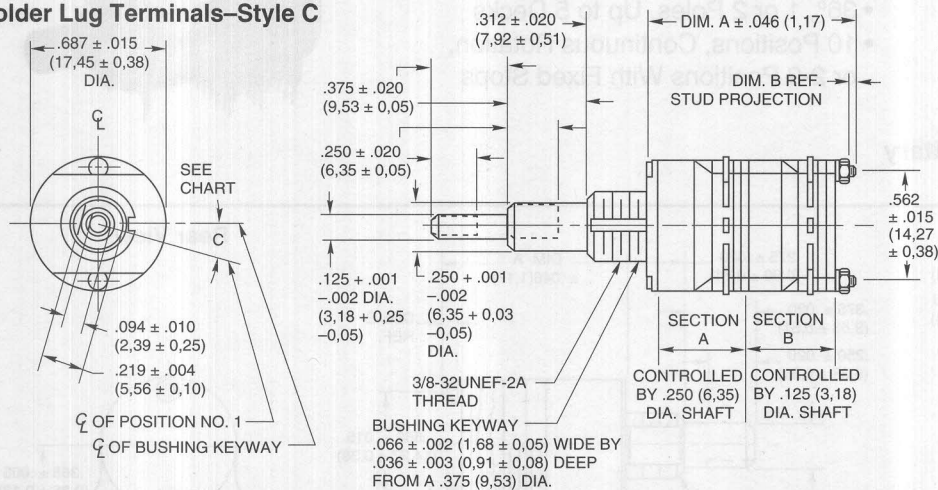
- Two Switches in the Panel Space of a Single Shaft Rotary

DIMENSIONS

In inches (and millimeters)



Solder Lug Terminals—Style C



No. of Decks		Dimension A	Dimension B	Approx. Weight Grams
Sec. A	Sec. B			
1	1	1.415 (35,94)	.032 (0,81)	24
2	1	1.633 (41,49)	.032 (0,81)	26
3	1	2.131 (54,13)	.312 (7,92)	28
1	2	1.633 (41,49)	.032 (0,81)	26
2	2	2.131 (54,13)	.312 (7,92)	28
3	2	2.349 (59,66)	.312 (7,92)	30
1	3	2.131 (54,13)	.312 (7,92)	28
2	3	2.349 (59,66)	.312 (7,92)	30
3	3	2.567 (65,20)	.312 (7,92)	32

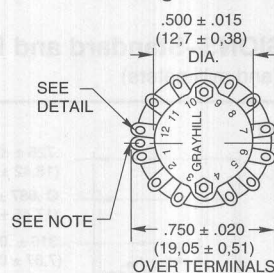
Angle C is 15° in 12 position switches and 36° in 10 position switches.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request.

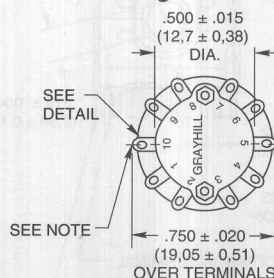
Rear Views

30° and 36° Angle of Throw may be interposed on either shaft diameter.

30° Angle of Throw

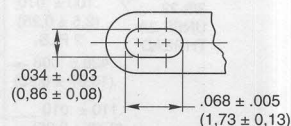


36° Angle of Throw



Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

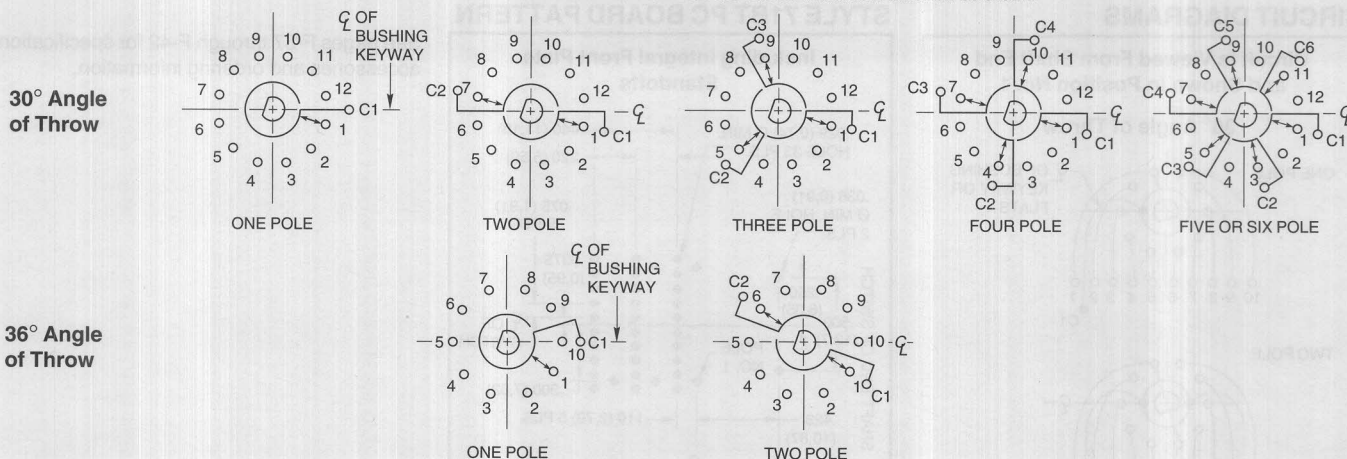
Terminal Detail



CIRCUIT DIAGRAMS—Solder Lug Terminals

Switch is Viewed From Shaft End and Shown in Position No. 1.

Note: All common terminals are located above base terminals as shown.



ADD-A-POT SWITCHES

Contact Grayhill for Series 71 Concentric Add-A-Pot or Add-A-Switch type switches.

See pages F-37 through F-42 for specifications, accessories and ordering information.

F-36

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

SPECIFICATIONS

Military Qualification MIL-S-3786/39

The military style of the Series 71 rotary switch is qualified to MIL-S-3786/39. Complete electrical rating information is listed on the following page. The Series 71 rotary switch qualification includes the 30° and the 36° angles of throw, in .125" (3,18) and .250" (6,35) diameter shafts, with solder lug terminals and printed circuit terminals, in sealed and unsealed style switches. Standard variations such as shaft and/or bushing length, etc. that do not affect the switch performance can also be marked as qualified product. Contact Grayhill for complete details.

Dimensionally the military style is the same as the standard style with the exception of the PC version of 3 or 4 decks; a spacer deck between decks 2 and 3 adds another deck length to the switch without increasing the number of operative decks.

Another difference in the standard and military styles is the mounting hardware. Ordered as options with a standard style switch these items are included with the military style switch: non-turn washer with solder lug style, and a non-turn washer plus a mounting bushing washer with the PC terminal style.

Complete specification drawings are available from GRAYHILL, Inc. for the standard military qualified products. Military qualified Series 71 rotary switches may be ordered by the "M" number listed in MILITARY Specification Sheet/39 or by GRAYHILL part number. All qualified switches will be marked to the specification.

Military Shaft and Panel Seal

A shaft and panel seal is available to provide water-tight mounting of the Series 71 standard military style rotary switches. Sealing is accomplished by an O-ring shaft seal and a panel seal washer. Panel seal dimension differences are shown in the dimensional drawings. When the panel seal is compressed, dimensions are approximately the same as an unsealed switch. If the non-turn washer supplied with the switch is used, it should not be allowed to extend entirely through the panel when mounting a sealed switch. However, the bushing may be used as a non-turn device instead. Switches are provided with a double flat bushing in styles which include the letter A, and with a bushing which has a keyway in the styles which include the letter B.

SPECIFICATIONS—Materials and Finishes

Materials and Finishes

Standard Style

Cover: Diallyl per Mil-M-14 except for 71 BT (see bushing).

Base and Deck Separator: Diallyl per Mil-M-14

Rotor Mounting Plate: Thermoplastic

Bushing: Zinc casting, cadmium plated per ZZ-P-416, Class 2, Type II.

Rear Support Plate: Stainless steel

Shaft, Stop Plates, Stop Arm (71BT):

Reinforced thermoplastic

Shaft, Stop Pins, Stop Arm (All Others):

Stainless steel

Detent Rotor: Reinforced thermoplastic for 71BT; phenolic per MIL-M-14 for all others

Detent Balls: Steel, nickel plated

Detent Springs: Tinned music wire

Rotor Contact: Silver alloy and beryllium copper

Base Contacts, Common Plate, and

Terminals: Brass, Gold plate .000005" minimum over Silver plate .00005" over Nickel .00002".

Front Support Plate (71 BT only):

Tempered steel, tin/lead plated.

Interdeck Seal (71 BT Only): Silicone

Throughbolts and Nuts, and Shaft

Extension: Brass, unplated

Mounting Hardware: One mounting nut and one internal tooth lockwasher are supplied with each switch. For switches with A in the style description, the nut is .062" (1,57) thick by .312" (7,92) across flats. For switches with B or C in the style description, the nut is .094" (2,39) thick by .562" (14,27) across flats. Nuts are brass, cadmium plated per QQ-P-416, Class 2, Type II.

Materials and Finishes

Military Qualified

Cover, Base, and Deck Separator: Diallyl per MIL-M-14

Rotor Mounting Plate: Thermoplastic

Bushing: Zinc, Cadmium plated per QQ-P-416, Class 2, Type II

Shaft, Shaft Extension, Stop Arm, Stop Pins, Rear Support Plate Through Bolts and Nuts:

Stainless Steel Passivated

Detent Balls: Steel, Nickel plated

Detent Springs: Tinned Music Wire

Rotor Contact: Silver Alloy and Beryllium

Copper

Base Contacts, Common Plate, and Termi-

nals: Brass, Gold plate .000005" minimum over Silver plate .00005" over Nickel .00002".

Detent Rotor: Phenolic per MIL-M-14.

Mounting Hardware: One mounting nut and one internal tooth lockwasher are supplied with each Series 71 switch. For switches with Style A in the description, the nut is .062" (1,57) thick by .312" (7,92) across flats. For switches with Style B or C in the description, the nut is .094" (2,39) thick by .562" (14,27) across flats. Nuts are Brass, Cadmium plated per QQ-P-416 Class 2, Type II.

Additional Hardware: Each switch is supplied with a non-turn washer to use if desired. Additionally, each PC mount switch is supplied with a mounting bushing washer (see PC Mount Accessory). For switches with Style A in the description, non-turn washer is Stainless Steel passivated; for switches with Style B in the description, non-turn washer is Brass, Cadmium plated. Mounting bushing washer (PC Mount Accessory) is Brass, Cadmium plated. For dimensions of non-turn washers see page F-40.

SPECIFICATIONS—Electrical Ratings, Others

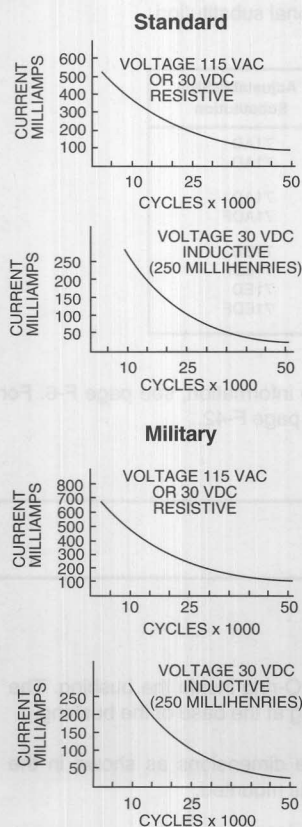
Electrical Ratings

General

Charts: Charts shown are for non-shorting (break before make) contacts. Measurements were made at 25°C and 68% relative humidity. The load life curves show the number of rotational cycles which can be expected for the voltage, current and type of load. Thus, for a standard style switch with a 300 milliampere 115 Vac resistive load, the expected life is 15,000 cycles. Reducing the load to 200 milliamperes increases the life to 25,000 cycles. Life limiting or failure criteria are listed in the rating sections which follow.

Cycles: A cycle is a 360° rotation and a return through all switch positions to the starting position.

Voltage: As listed in charts.



Electrical Ratings

Standard Style

Curves are based on the following failure criteria:

Contact Resistance: 50 milliohms maximum (20 milliohms initially).

Insulation Resistance: 1,000 megohms minimum between terminals and shaft. (50,000 megohms initially).

Voltage Breakdown: 500 Vac minimum between mutually insulated parts.

Current Rating: These switches will carry 4 amperes with a maximum contact temperature rise of 20°C. If the life limiting characteristics are less critical than those shown above, if elevated temperatures or reduced pressures are involved, GRAYHILL can predict the switch life for the application.

Meet the Following Requirements of MIL-S-3786: Moisture Resistance: Medium and High Shock; Vibration (10 to 2,000 cps); Thermal Shock (-65°C to 85°C); Salt Spray, Explosion; and Stop Strength (10 in-lb).

Electrical Ratings

Military Style

Curves are based on the following failure criteria:

Qualified to the following MIL-S-3786/39 circuit values: (also see standard style description.) The Series 71 has been tested to meet the requirements of MIL-S-3786, Style SR39, the majority of which are listed here. At 85°C approximately 68% relative humidity and sea level pressure, the switches have been tested to make and break the following loads, as stated in MIL-S-3786/39: 125 milliamperes at 28 Vdc resistive; 75 milliamperes at 115 Vac resistive.

The switches have also been tested at reduced barometric pressure (70,000 feet), 25°C at approximately 68% relative humidity to make and break the following loads as stated in MIL-S-3786/39: 50 milliamperes, 28 Vdc resistive; 20 milliamperes, 115 Vac resistive. When tested to the above loads at stated conditions, the Series 71 switches meet the following life-limiting criteria after 25,000 cycles of operation in accordance with MIL-S-3786/39.

Contact Resistance: 50 milliohms maximum after life.

Insulation Resistance: 1,000 megohms minimum between terminals and shaft.

Dielectric Strength: 500 Vac (atmospheric pressure) and 350 Vac (reduced pressure) between mutually insulated parts.

The Series 71 also meets the requirements of MIL-S-3786/39 for moisture resistance, stop strength, rotational torque, vibration (10 through 2,000 cps), medium and high shock, salt spray, explosion, thermal shock (-65°C to 85°C), and terminal pull. When tested at sea level, 25°C and 68% relative humidity with failure criteria of 50 milliohms maximum contact resistance and 500 Vac breakdown voltage, these switches will make and break 250 milliamperes at 28 Vdc inductive (250 millihenries) 500 milliamperes at 28 Vdc resistive; 500 milliamperes at 115 volts Vac, 60 hertz resistive, for 10,000 cycles of operation.

Additional Characteristics

Standard and Military Styles

Rotational Torque: 4-32 ounce-inches, (28-230 N•mm) depending on the number of poles per deck and the number of decks.

Contacts: Shorting or non-shorting wiping contacts with over 100 grams of contact force.

Shaft Flat Orientation: Opposite first position pole no. 1 (See Circuit Diagrams).

Terminals: Switches are provided with full circle of terminals regardless of the number of active positions.

Extended Studs: Switches of 6 or more decks (or concentric switches of 4 or more) have longer studs and extra stud nuts for recommended double end mounting. Stud hole size is 1/16" diameter for #0-80 NF-2A thread.

Stop Strength: 10 pound-inches.

Mounting Bushing Strength: 10 pound-inches.

STANDARD OPTIONS

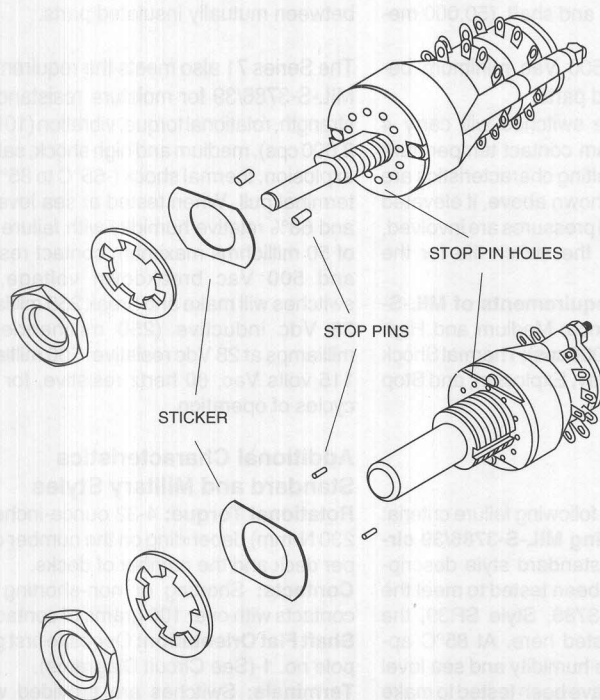
Intermixing of shorting/non-shorting, RFI grounding, and shielding.

See pages F-9 and F-10.

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

ADJUSTABLE STOPS

Set and Reset Stops to Limit Rotation Form, Fit, Function Equivalent to Fixed Stop Styles



The adjustable stop Series 71 rotary switches allow you to change the number of positions per pole. Simply remove and relocate stop pins in the holes in the front of the switch. The pins are held in place by a self adhesive sticker which fits over the front plate.

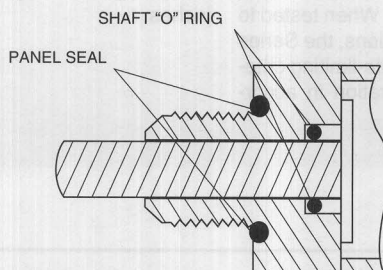
This feature is available in the Series 71 single shaft standard switches with either 1/8" or 1/4" diameter shafts with either PC or solder lug terminals. It is not available in military qualified or concentric shaft styles.

All dimensions, ratings and characteristics are the same as the fixed stop equivalent. The chart shown here describes the adjustable stop style substitutions for the fixed stop styles. Although Series 71 is not an exact dimensional equivalent of the fixed stop styles of Series 8 and 9, it most nearly represents a functional substitution.

Fixed Stop Style	Adjustable Stop Substitution
8A	71AD
9A	71AD
71A	71AD
71AF	71ADF
71B	71BD
71BF	71BDF
71E	71ED
71EF	71EDF

For more adjustable stop information, see page F-6. For ordering information, see page F-42.

SHAFT AND PANEL SEAL



The shaft is sealed by an O-ring inside the bushing. The panel is sealed by an O-ring at the base of the bushing.

The seals do not alter the dimensions as shown in the drawings when the switch is mounted.

The panel seal is silicone rubber. The shaft seal is an O-ring per MIL-P-5516B.

ACCESSORIES FOR 1/4 AMP ROTARY SWITCHES

ACCESSORIES—Non-Turn Washers In inches (and millimeters)

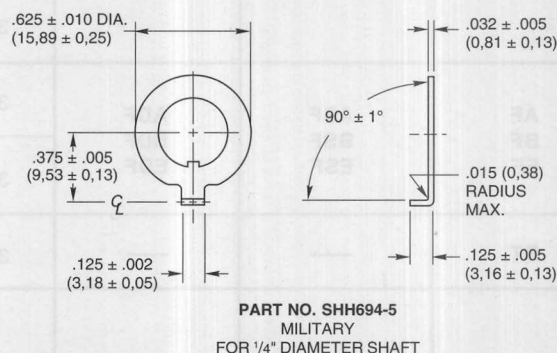
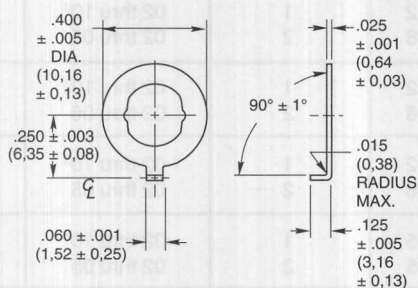
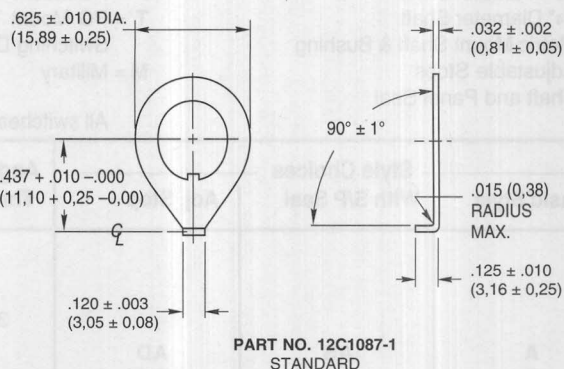
1/8" and 1/4" Diameter Shaft Switches

The bushing of the Series 71 switch is designed so the switch will not turn if the panel has been cut to fit the exact bushing shape. The bushing for the 1/8" diameter shaft switch has a double flat; the 1/4" diameter shaft switch has a keyway in the bushing. An alternate means of keeping the switches from turning is to mount them with optional, non-turn washers.

Part number 50J1066 is made of Stainless Steel. It is supplied with military switches with Style A in the description. When ordered for standard product, a like number of switches must be ordered.

Part number 12C1087-1 is Brass, Cadmium plated and may be ordered for standard product.

Part number SHH694-5 is Stainless Steel washer supplied with all military style switches with Style B in the description.



4 mm Diameter Shaft Switches

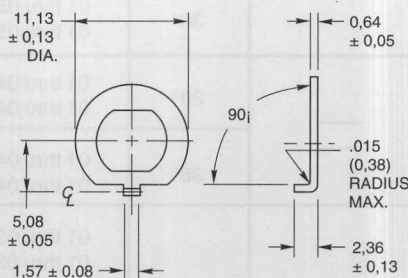
Non-Turn Washer

For styles E, ED, EF and EDF.

Mounting bushing washer provides non-turn feature.

302 Stainless Steel.

Part No. 71 J1103. Contact Grayhill for price.



ECONOMICAL, 1/4 AMP ROTARY SWITCHES

CHOICES AND LIMITATIONS—Series 71

A = 1/8" Diameter Shaft
 B = 1/4" Diameter Shaft
 E = Metric Mount Shaft & Bushing
 D = Adjustable Stops
 S = Shaft and Panel Seal

F = PC Mount Terminals
 T = PC Mount Terminals and Process Sealed
 Switching Decks & Bushing; no panel seal
 M = Military

C = Concentric Shaft
 2 Switches with same Style and Angle of
 Throw, one behind the other.
 Limits below apply to either switch section
 (A or B).

All switches without F or T have solder lugs

Basic Style	Style Choices With S/P Seal	Adj. Stop	Angle of Throw	No. Of Decks	Poles Per Deck	Positions Per Pole ¹	Shorting Or Non-Shorting
A B E	AS BS ES	AD BD ED	30°	01 thru 12	1	02 thru 12 ³	N or S
				01 thru 08	2	02 thru 06	N or S
				01 thru 05	3	02 thru 04	N or S
				01 thru 04	4	02 or 03	N or S
				01 thru 03	5 ⁵	02	N or S
				01 or 02	6 ⁵	02	N or S
AF BF EF	ASF BSF ESF	ADF BDF EDF	30°	01 thru 12	1	02 thru 12 ³	N or S
				01 thru 08	2	02 thru 06	N or S
			36°	01 thru 12	1	02 thru 10 ³	N or S
				01 thru 08	2	02 thru 05	N or S
BT	—	—	36°	01 thru 05	1	02 thru 10 ³	N or S
				01 thru 05	2	02 thru 05	N or S
MA MB	MAS MBS	—	30°	01 thru 05 ⁴	1	02 thru 12 ³	N or S
				01 thru 05 ⁴	2	02 thru 06	N or S
				01 thru 05 ⁴	3	02 thru 04	N or S
				01 thru 04 ⁴	4	02 or 03	N or S
MAF MBF	MASF MBSF	—	30°	01 thru 04 ^{2,4}	1	02 thru 12 ³	N or S
				01 thru 04 ^{2,4}	2	02 thru 06	N or S
			36°	01 thru 04 ^{2,4}	1	02 thru 10 ³	N or S
				01 thru 04 ^{2,4}	2	02 thru 05	N or S
C	—	—	30°	01 thru 03	1	02 thru 12 ³	N or S
				01 thru 03	2	02 thru 06	N or S
				01 or 02	3	02 thru 04	N or S
				01	4	02 or 03	N or S
				01	5	02	N or S
				01	6	02	N or S
CF	—	—	36°	01 thru 03	1	02 thru 10 ³	N or S
				01 thru 03	2	02 thru 05	N or S
			30°	01 thru 03	1	02 thru 12 ³	N or S
				01 thru 03	2	02 thru 06	N or S

¹ For Adjustable Stop styles (with the letter D), use AJ instead of number of positions when ordering.

² Military Qualified PC mount switches of 3 or 4 operative decks have an additional spacer deck after deck 2. Use total decks to calculate length;

but use only the number of *operative* decks when creating the part number.

³ For 1-pole switches with maximum positions, specify Fixed stop after last position or Continuous rotation when ordering. (Note: 1 p, 71BT, 10 positions, is available only as Continuous).

⁴ In addition to qualified types (Solder lug—5 decks; PC mount—4 decks), Grayhill can provide switches with additional decks in the materials of the 'M' style. Contact Grayhill.

⁵ Switches in 30° throw with 5 or 6 poles per deck are not available with adjustable stops.

ECONOMICAL, 1/4 AMP ROTARY SWITCHES

ORDERING INFORMATION—Single Shaft Switches

71A30—02—1—12N—C

Series

Style: Letter(s) from the Choices and Limitations chart

Angle of Throw: 30° or 36°

Number of Decks: As limited by Choices and Limitations chart

Stop Arrangement: Use suffix only when ordering 1 pole with maximum positions.

C = Continuous rotation; F = Stop between last and first positions

Type of Contacts: N = Non-shorting; S = Shorting

Positions Per Pole: 02 to 12 per Choices chart.

For adjustable stop switches (D) use AJ here.

Poles Per Deck: As limited by the Choices chart

ORDERING INFORMATION—Concentric Shaft Switches

71C362110NC—3202S

Entire Switch

Series and Style: 71C or 71CF

Angle of Throw: 30° or 36°. Both switch sections will be the same.

Switch Section A (Front Switch)

Number of Decks: 1 to 3, per Choices and Limitations chart

Poles Per Deck: As limited by the Choices and Limitations chart

Positions Per Pole: 02 to 12 per Choices and Limitations chart

Type of Contacts: N = Non-shorting; S = Shorting

Stop Arrangement: Use suffix only when ordering 1 pole with maximum positions.

C = Continuous rotation; F = Stop between last and first positions

Switch Section B (Rear Switch)

Stop Arrangement: Use suffix only when ordering 1 pole with maximum positions.

C = Continuous rotation; F = Stop between last and first positions

Type of Contacts: N = Non-shorting; S = Shorting

Positions Per Pole: 02 to 12 per Choices and Limitations chart.

Poles Per Deck: As limited by the Choices and Limitations chart

Number of Decks: 1 to 3, per Choices and Limitations chart

Available from your local Grayhill Distributor
For prices and discounts, contact a Local Sales Office, an authorized local Distributor, or Grayhill.

1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

SERIES 8 AND 9

FEATURES

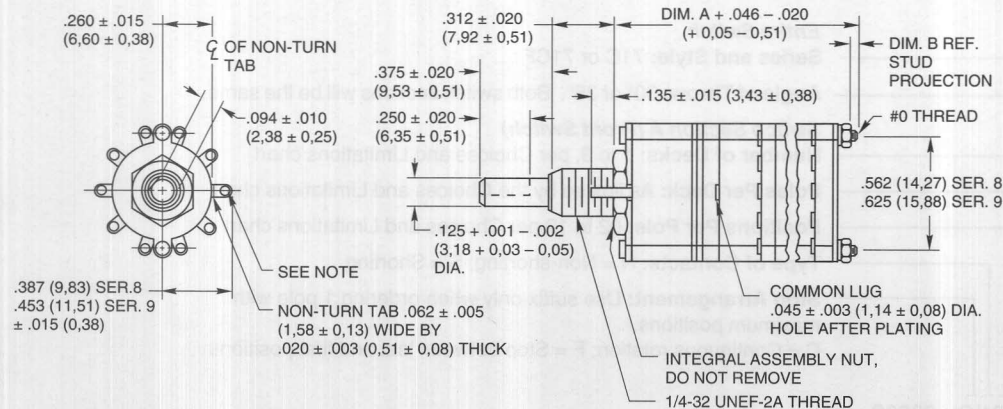
- Proven Quality in Thousands of Applications
- Gold Plated Contact System
- 30°, 36°, 45°, 60° and 90° Angle of Throw Options
- MIL Qualified Versions MIL-S-3786/13



DIMENSIONS In inches (and millimeters)

Standard Style

Front view shows terminal location of Series 8, 36° angle of throw. Transpose rear view for terminal location of other angles of throw.



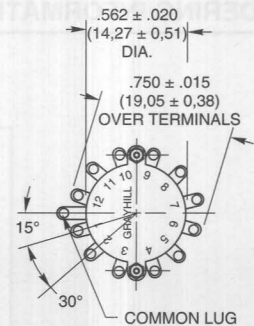
Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.

No. Of Decks	Dimension A	Dimension B	Approx. Weight Grams		No. Of Decks	Dimension A	Dimension B	Approx. Weight Grams	
			Srs. 8	Srs. 9				Srs. 8	Srs. 9
1	.960 (24,38)	.062 (1,57)	12	16.0	7	2.818 (71,58)	.312 (7,92)	24	31.0
2	1.228 (31,19)	.062 (1,57)	14	18.5	8	3.086 (78,38)	.312 (7,92)	26	33.5
3	1.496 (38,00)	.062 (1,57)	16	21.0	9	3.354 (85,19)	.312 (7,92)	28	36.0
4	1.764 (44,81)	.062 (1,57)	18	23.5	10	3.622 (91,00)	.312 (7,92)	30	38.5
5	2.032 (51,61)	.062 (1,57)	20	26.0	11	3.890 (98,81)	.312 (7,92)	32	41.0
6	2.550 (64,77)	.312 (7,92)	22	28.5	12	4.158 (105,61)	.312 (7,92)	34	43.5

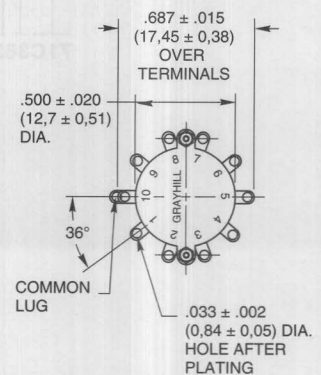
Grayhill part number and date code marked on standard style detent cover label. Customer part number marked on request. Grayhill part number and date code printed on military style cover. Military number printed when required.

Rear Views

Series 9 30° Angle of Throw



Series 8 36° Angle of Throw



For rear view of 45°, 60° and 90°, see circuit diagrams.

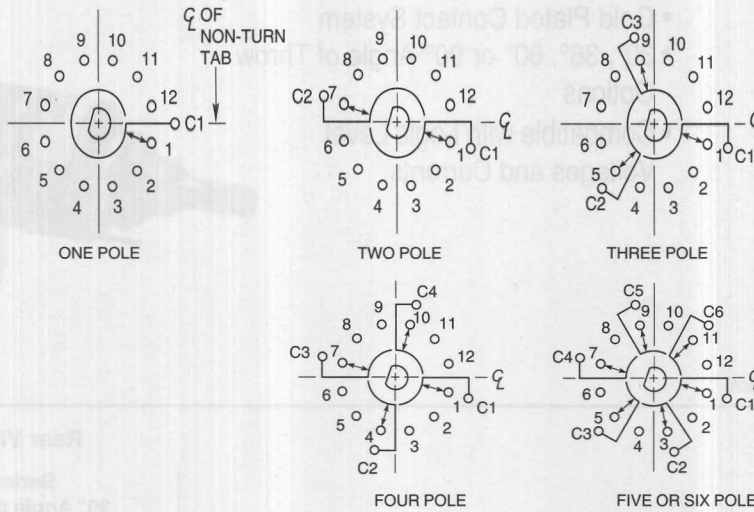
See pages F-47 and F-48 for specifications and ordering information.

CIRCUIT DIAGRAMS—Solder Lug Terminals

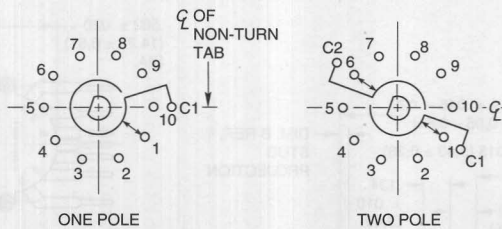
Switch is Viewed From Shaft End and Shown in Position No. 1

Note: All common terminals are located above base terminals as shown.

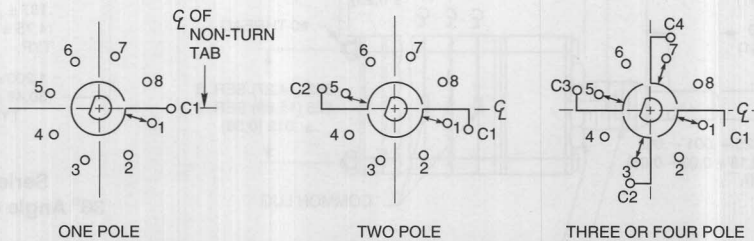
**Series 9
30° Angle
of Throw**



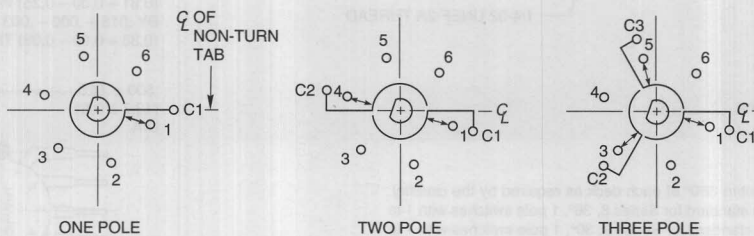
**Series 8
36° Angle
of Throw**



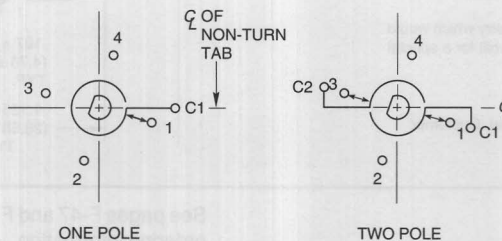
**Series 9
45° Angle
of Throw**



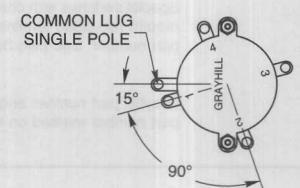
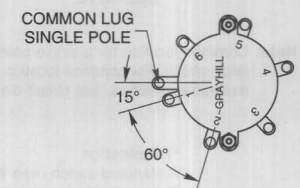
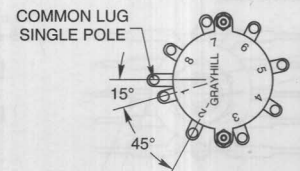
**Series 9
60° Angle
of Throw**



**Series 9
90° Angle
of Throw**



Rear Views

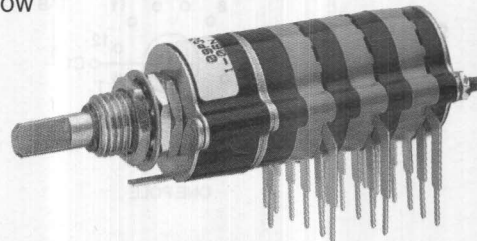


1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

SERIES 8 AND 9-PC MOUNT

FEATURES

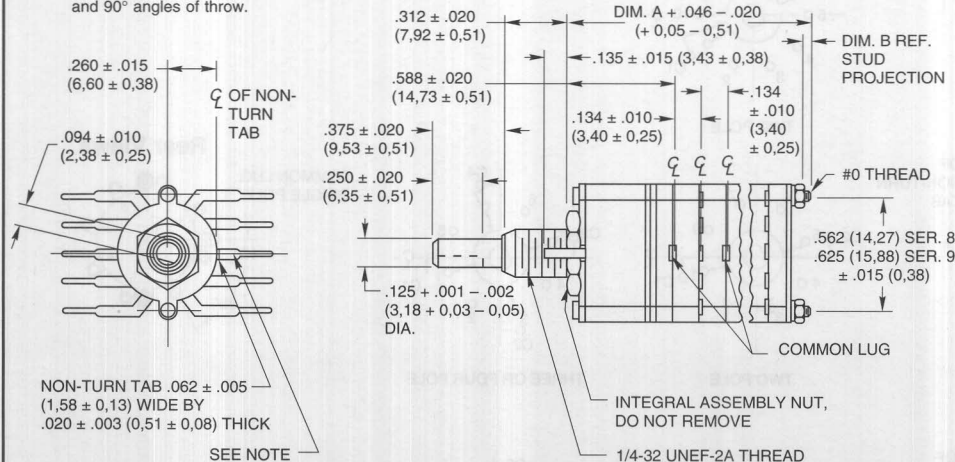
- Gold Plated Contact System
- 30°, 36°, 60° or 90° Angle of Throw Options
- Compatible with Logic Level Voltages and Currents



DIMENSIONS In inches (and millimeters)

PC Mount Style

Front view shows terminal location of 36° angle of throw. Transpose rear view for terminal location of 30° angle of throw. See Circuit Diagrams for 60° and 90° angles of throw.



Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.

*Termination

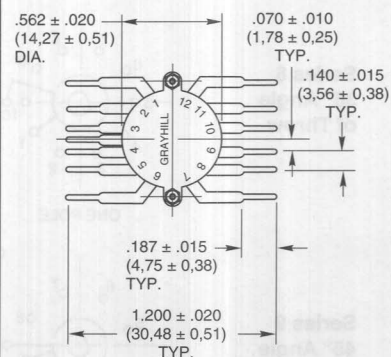
A standard switch uses the entire 360° of each deck as required by the circuitry. Thus one-sided termination is standard for Series 8, 36°, 1 pole switches with 1 to 5 positions per pole; it is also standard for Series 9, 30°, 1 pole switches with 1 to 6 positions per pole. Two-sided termination is standard for 1 pole switches with more positions per pole and for switches of 2 or more poles per deck.

Special switches with one-sided termination can be made for circuitry which would require two-sided termination in standard switches. Contact Grayhill for a special part number. See also Special Options, page F-10.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request.

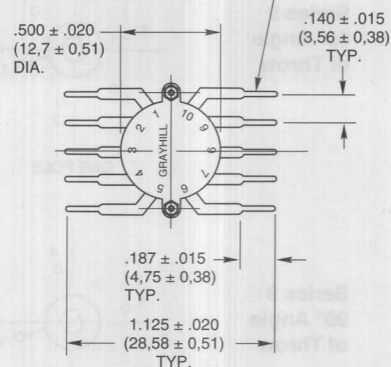
Rear Views

Series 9 30° Angle of Throw



Series 8 36° Angle of Throw

TERMINAL DIMENSIONS AT THIS POINT ARE .032 ± .000 - .010 (0,81 ± 0,00 - 0,25) WIDE BY .015 ± .000 - .003 (0,38 ± 0,00 - 0,08) THICK



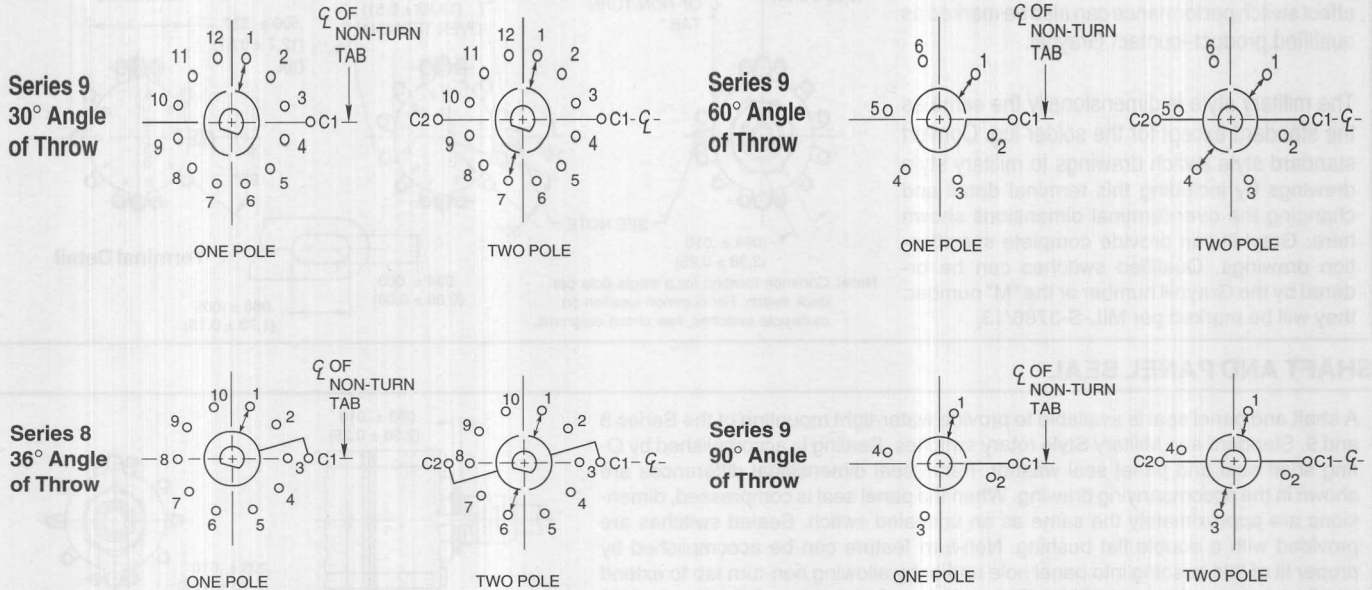
See pages F-47 and F-48 for specifications and ordering information.

1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

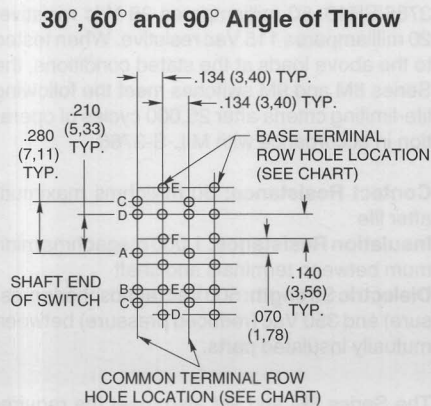
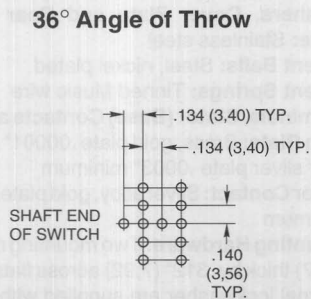
CIRCUIT DIAGRAMS—PC Mount

Switch is Viewed From Shaft End and Shown in Position No. 1

Note: All common terminals are located above base terminals as shown.



PC BOARD MOUNTING PATTERN



Number of Poles Per Deck	Common Terminal Hole Location
1 Pole Per Deck	A
2 Poles Per Deck	A

Angle of Throw	Base Terminals Hole Location
30°	All
60°	E and F
90°	D and F

Diagrams shown for a two deck switch. Bushing mounting is recommended for all PC mount rotary switches.

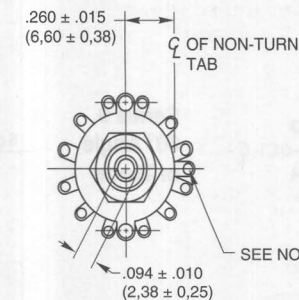
1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

MILITARY QUALIFIED

Series 8 and 9 military switches are qualified to MIL-S-3786/13. They include 30°, 36°, 45° and 60° angles of throw with solder lug terminals in sealed and unsealed styles. See front and rear views at right. Standard variations which do not affect switch performance can also be marked as qualified product—contact Grayhill.

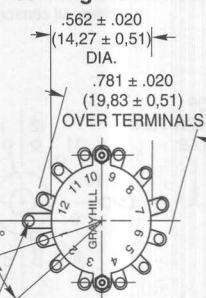
The military style is dimensionally the same as the standard except for the solder lug. Convert standard style switch drawings to military style drawings by including this terminal detail and changing the over-terminal dimensions shown here. Grayhill can provide complete specification drawings. Qualified switches can be ordered by the Grayhill number or the "M" number; they will be marked per MIL-S-3786/13.

Front view shows terminal location of Series 9, 30° angle of throw. Transpose rear view for terminal location of other angles of throw.

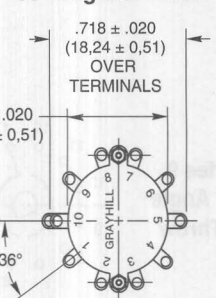


Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.

Series 9 30° Angle of Throw



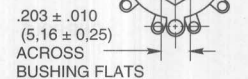
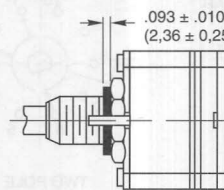
Series 8 36° Angle of Throw



Terminal Detail

SHAFT AND PANEL SEAL

A shaft and panel seal is available to provide water-tight mounting of the Series 8 and 9. Standard and Military Style rotary switches. Sealing is accomplished by O-ring shaft seal and panel seal washer. Panel seal dimensional differences are shown in the accompanying drawing. When the panel seal is compressed, dimensions are approximately the same as an unsealed switch. Sealed switches are provided with a double flat bushing. Non-turn feature can be accomplished by proper fit of this bushing into panel hole and/or by allowing non-turn tab to extend into (but not through) panel. Military Style rotary sealed switches do not have a non-turn tab.



SPECIFICATIONS

Electrical Ratings

Standard Style

Rated: To make and break the following loads: 1/4 amp, 115 Vac resistive; 1/4 amp, 6-28 Vdc resistive; 20 mA, 115 Vdc resistive; 50 mA, 115 Vac inductive; 20 mA, 28 Vdc inductive; to carry 4 amps continuous.

Contact Resistance: After 25,000 cycles of operation, 50 milliohms maximum

Insulation Resistance: 1,000 megohms minimum between terminals and shaft

Voltage Breakdown: 1,000 Vac initially (500 Vac or better after most environmental tests)

Life Expectancy: 50,000 mechanical cycles of operation. Note: Actual life is determined by a number of factors, including electrical loading, rate of rotation and environment, as well as maximum contact resistance, minimum insulation resistance, and minimum voltage breakdown required at the end of life.

Electrical Ratings

Military Qualified

Qualified to the following MIL-S-3786/13 Circuit Values: (Also see Standard Style description.) The Series 8M and 9M have been tested to meet the requirements of MIL-S-3786, Style SR13, the majority of which are listed. At 85°C, approximately 68% relative humidity and sea level pressure, the switches have been tested to make and break the following loads, as stated in MIL-S-3786/SR13: 125 milliamperes at 28 Vdc resistive; 75 milliamperes at 115 Vac resistive.

The switches have also been tested at reduced barometric pressure (70,000 feet), 25°C at approximately 68% relative humidity to make and break the following loads as stated in MIL-S-3786/SR13. 50 milliamperes 28 Vdc resistive; 20 milliamperes 115 Vac resistive. When tested to the above loads at the stated conditions, the Series 8M and 9M switches meet the following life-limiting criteria after 25,000 cycles of operation in accordance with MIL-S-3786.

Contact Resistance: 50 milliohms maximum after life

Insulation Resistance: 1,000 megohms minimum between terminals and shaft

Dielectric Strength: 500 Vac (atmospheric pressure) and 350 Vac (reduced pressure) between mutually insulated parts.

The Series 8M and 9M also meet the requirements of MIL-S-3786 SR13 for moisture resistance, stop strength, rotational torque, vibration (10 to 2,000 cps), medium and high shock, salt spray, explosion, thermal shock (-65°C to 85°C) and terminal pull. When tested at sea level, 25°C and 68% relative humidity with failure criteria of 50 milliohms maximum contact resistance and 500 Vac breakdown voltage, these switches will make and break 250 mA at 28 Vdc inductive (250 millihenries): 1/2 amp: at 28 Vdc resistive: 1/2 amp; at 115 Vac: 60 Hz resistive for 10,000 cycles of operation.

Materials and Finishes

Standard Style

Switch Bases: Melamine per MIL-M-14

Cover, Deck Separators and End Plate: Phenolic per MIL-M-14

Rotor Mounting Plate: Thermoplastic

Mounting Bushing and Nuts: Brass, cadmium plated

Shaft, Retaining Rings, Through Bolts, Shaft Extension, Stop Washers, Stop Arm, Thrust Washers, Cover Plate and Rear Support Plate: Stainless steel

Detent Balls: Steel, nickel plated

Detent Springs: Tinned Music wire

Terminals, Stator (Base) Contacts and Common Plate: Brass, gold plate .00001" minimum over silver plate .0003" minimum

Rotor Contact: Silver alloy, gold plated .00001" minimum

Mounting Hardware: Two mounting nuts .062" (1,57) thick by .312" (7,92) across flats and one internal lockwasher are supplied with switch.

Materials and Finishes

Military Qualified

Deck Separators, End Plate and Switch Bases: Diallyl per MIL-M-14

Rotor Mounting Plate: Thermoplastic

Mounting Bushing and Nuts: Brass, cadmium plated per QQ-P-416, Class 2, Type II

Shaft, Cover, Stop Plate, Retaining Ring, Through Bolts, Shaft Extension, Stop Arm, Thrust Washers, Cover Plate and Rear Support Plate: Stainless steel

Detent Balls: Steel, nickel plated

Detent Springs: Tinned music wire

Terminals, Stator (Base) Contacts and Common Plate: Brass, gold plate .00001" minimum over silver plate .0003" minimum

Rotor Contact: Silver alloy, gold plated .00001" minimum

Mounting Hardware: Two mounting nuts .062" (1,57) thick by .312" (7,92) across flats and one internal tooth lockwasher are supplied with this switch.

1/2" DIAMETER, 1/4 AMP ROTARY SWITCHES

ADDITIONAL CHARACTERISTICS Standard Style and Military Qualified

Contacts: Shorting or Non-shorting contacts available in 30°, 36° and 45° angle of throw rotary switches. Non-shorting contacts available in 60° and 90° angle of throw switches. All are wiping contacts with over 100 grams of contact force.

Stop Strength: 12 pound-inches minimum
Rotational Torque: 8-64 ounce-inches depending upon the number of poles per deck and the number of decks

Extended Studs: Switches of six decks or more have longer studs with extra stud nuts for recommended double end mounting.

ADJUSTABLE STOPS

See Series 71 Rotary Switches, page F-39.

STANDARD OPTIONS

See Options, pages F-9 and F-10. Terminals, Shielding, etc.

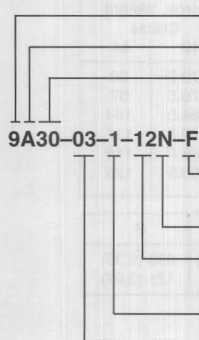
ADDITIONAL FEATURES

Spring Return, Keylocks, Isolated Positions. See Features selection chart, page F-7.

CHOICES AND LIMITATIONS

Series	Style and Designation	Angle of Throw	Stops	Terminals	Number of Decks		Poles Per Deck	Number of Positions/Pole
					Shorting	Non-Shorting		
8	A = Standard S = Standard, Shaft/Panel Seal M = Military Style MS = Style M, Shaft/Panel Seal	36°	Fixed	Solder	01 thru 12 01 thru 09	01 thru 12 01 thru 09	1 2	02 thru 10 02 thru 05
	P = Standard, PC Mount SP = Style P, Shaft/Panel Seal MP = Military Style, PC Mount MSP = Style MP, Shaft/Panel Seal			Printed Circuit	01 thru 12 01 thru 09	01 thru 12 01 thru 09	1 2	02 thru 10 02 thru 05
9	A = Standard S = Standard, Shaft/Panel Seal M = Military Style MS = Style M, Shaft/Panel Seal	30°	Fixed	Solder	01 thru 12 01 thru 09 01 thru 06 01 thru 04 01 thru 03 01 thru 03	01 thru 12 01 thru 09 01 thru 06 01 thru 04 01 thru 03 01 thru 03	1 2 3 4 5 6	02 thru 12 02 thru 06 02 thru 04 02 or 03 02 02
	P = Standard, PC Mount SP = Style P, Shaft/Panel Seal MP = Military Style, PC Mount MSP = Style MP, Shaft/Panel Seal			Printed Circuit	01 thru 12 01 thru 09	01 thru 12 01 thru 09	1 2	02 thru 12 02 thru 06
	A = Standard, S = Standard, Shaft/Panel Seal M = Military Style MS = Style M, Shaft/Panel Seal	45°		Solder	01 thru 12 01 thru 06 01 thru 04 01 thru 03	01 thru 12 01 thru 06 01 thru 04 01 thru 03	1 2 3 4	02 thru 08 02 thru 04 02 02
	A = Standard, S = Standard, Shaft/Panel Seal M = Military Style MS = Style M, Shaft/Panel Seal				Not Available	01 thru 06 01 thru 03 01 or 02	1 2 3	02 thru 006 02 or 03 02
	P = Standard, PC Mount SP = Style P, Shaft/Panel Seal MP = Military Style, PC Mount MSP = Style MP, Shaft/Panel Seal	60°		Printed Circuit	Not Available	01 thru 06 01 thru 03	1 2	02 thru 06 02 or 03
	A = Standard S = Standard, Shaft/Panel Seal			90°	Solder	Not Available	01 thru 06 01 thru 03	1 2
	P = Standard, PC Mount SP = Style, Shaft/Panel Seal	Printed Circuit			Not Available	01 thru 06 01 thru 03	1 2	02 thru 04 02

ORDERING INFORMATION



9A30-03-1-12N-F

Series: determined by the angle of throw

Style: Letter(s) from the Choices and Limitations chart

Angle of Throw: Must agree with Series Number

Stop Arrangement: Add letter F to a one pole per deck switch with the maximum number of positions for a stop between position 1 and the last position. Leave blank for continuous rotation

Type of Contacts: N = Non-shorting; S = Shorting

Positions Per Pole: Requires 02 positions as a minimum to the maximum allowable dependent on the angle of throw and poles per deck

Poles Per Deck: As limited by angle of throw and switch style

Number of Decks: As limited by the angle of throw, the poles per deck, switch style and types of contacts

Available from your local Grayhill Distributor

For prices and discounts, contact a Local Sales Office, an authorized local Distributor, or Grayhill.



561 Hillgrove Avenue • LaGrange, Illinois 60525 • USA • Phone: (708) 354-1040 • Fax: (708) 354-2820 • <http://www.grayhill.com>

1" DIAMETER, 1 AMP ROTARY SWITCHES

SERIES 42, 43, 44 AND 54

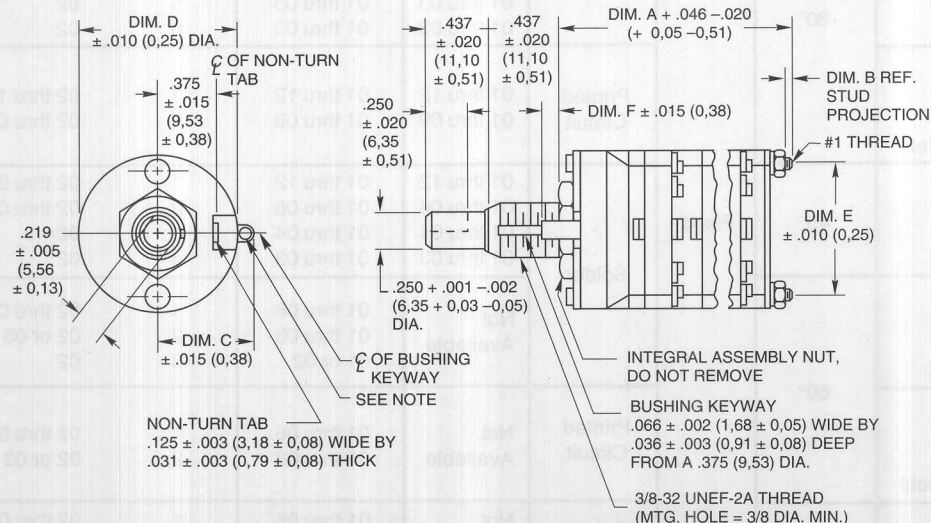
FEATURES

- Rugged Construction Insures Switch Operation for the Life of your Equipment
- Many Circuitry Options
- MIL Qualified Versions MIL-S-3786/04
- Features Choice Include: Shaft/ Panel Seal, Adjustable Stops, PC Termination, UL Recognized



DIMENSIONS In inches (and millimeters)

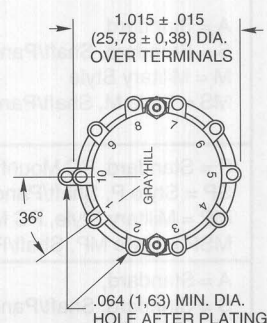
Standard, UL Recognized and Military Qualified Solder Lug Styles



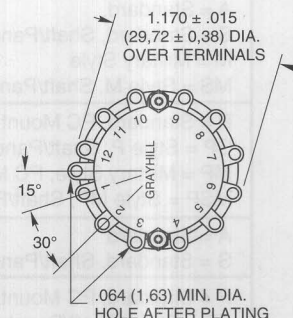
Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.

Rear Views

Series 42



Series 44



For rear view of 45°, 60° and 90°, see circuit diagram.

No. of Decks	Dimension A	Dimension B		Approx. Weight Grams		No. of Decks	Dimension A	Dimension B		Approx. Weight Grams	
		Style A	Style M or H					Style A	Style M or H		
1	1.025 (26,04)	.062 (1,57)	.030 (0,76)	40.0	48	7	3.351 (85,16)	.312 (7,92)	.280 (7,11)	73.0	90
2	1.371 (34,82)	.062 (1,57)	.030 (0,76)	45.5	55	8	3.697 (93,90)	.312 (7,92)	.280 (7,11)	78.5	97
3	1.717 (43,61)	.062 (1,57)	.030 (0,76)	51.0	62	9	4.043 (102,69)	.312 (7,92)	.280 (7,11)	84.0	104
4	2.063 (52,40)	.062 (1,57)	.030 (0,76)	56.5	69	10	4.389 (111,48)	.312 (7,92)	.280 (7,11)	89.5	111
5	2.409 (61,19)	.062 (1,57)	.030 (0,76)	62.0	76	11	4.735 (120,27)	.312 (7,92)	.280 (7,11)	95.0	118
6	3.005 (76,33)	.312 (7,92)	.280 (7,11)	67.5	83	12	5.081 (129,06)	.312 (7,92)	.280 (7,11)	100.5	125

Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required. UL recognized markings as required.

Dimension	C	D	E	F
Series 42	.562 (14,27)	1.000 (25,4)	.830 (21,08)	.093 (2,36)
Series 44	.642 (16,31)	1.162 (29,51)	1.000 (25,4)	.121 (3,07)

See pages F-55 through F-58 for specifications, accessories and ordering information.

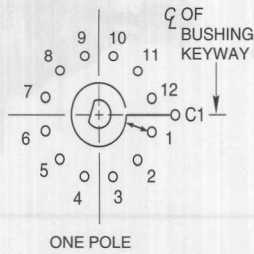
1" DIAMETER, 1 AMP ROTARY SWITCHES

CIRCUIT DIAGRAMS—Solder Lug Terminals

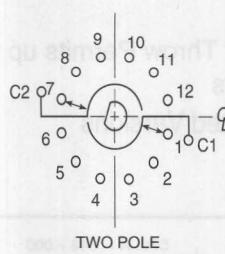
Switch is Viewed From Shaft End and Shown in Position No. 1

Note: All common terminals are located above base terminals as shown.

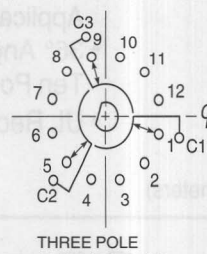
Series 44 & 54
30° Angle
of Throw



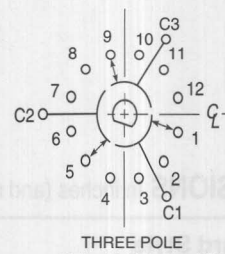
ONE POLE



TWO POLE

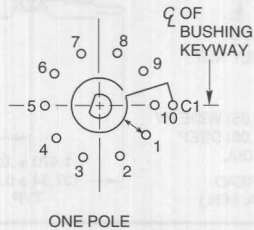


THREE POLE
Styles A, D and S

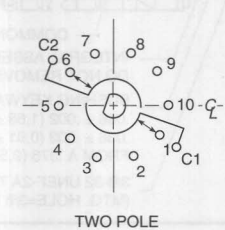


THREE POLE
Styles M, MS, H and HS

Series 42 & 43
36° Angle
of Throw

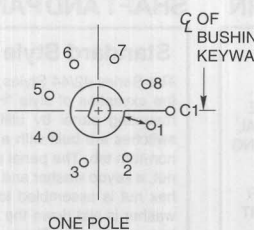


ONE POLE

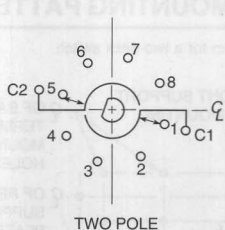


TWO POLE

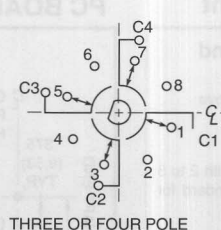
Series 44
45° Angle
of Throw



ONE POLE

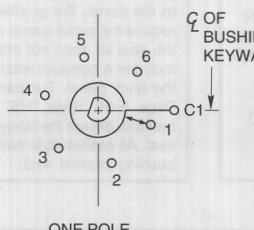


TWO POLE

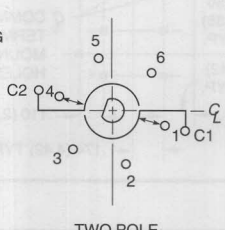


THREE OR FOUR POLE

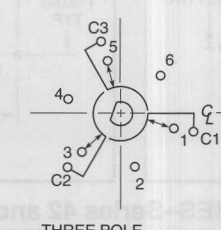
Series 44
60° Angle
of Throw



ONE POLE

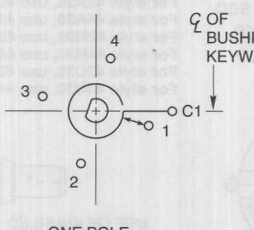


TWO POLE

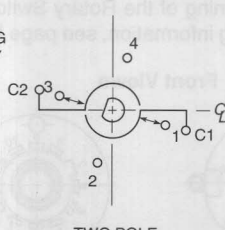


THREE POLE

Series 44
90° Angle
of Throw

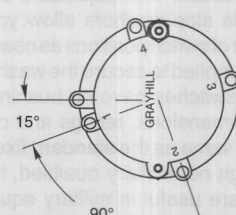
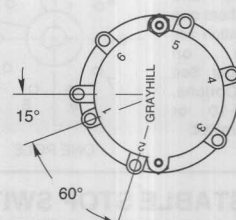
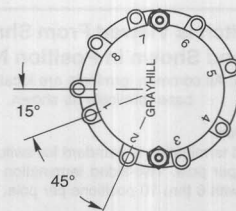


ONE POLE



TWO POLE

Rear Views

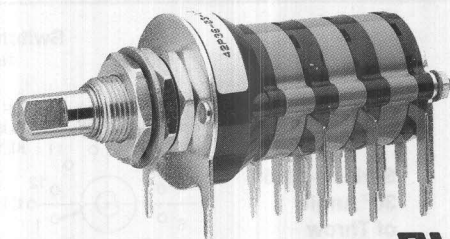


1" DIAMETER, 1 AMP ROTARY SWITCHES

SERIES 42-PC MOUNT

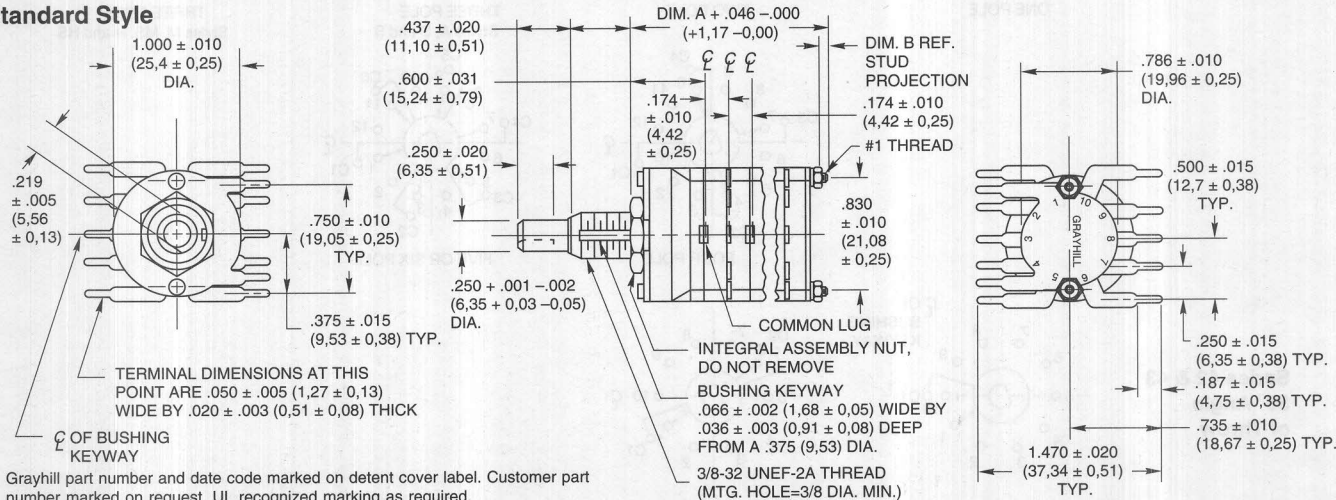
FEATURES

- Satisfies High Current Board Level Applications
- 36° Angle of Throw Permits up to Ten Positions
- UL Recognized Versions



DIMENSIONS In inches (and millimeters)

Standard Style



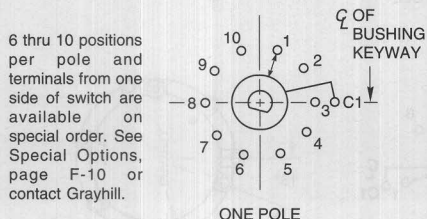
CIRCUIT DIAGRAM—PC Mount

**Switch is Viewed From Shaft End
and Shown in Position No. 1**

Note: All common terminals are located above base terminals as shown.

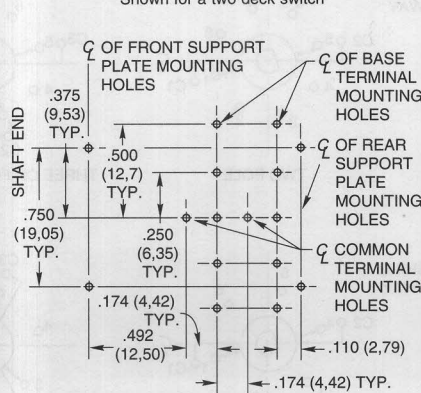
Termination

One-sided termination is standard for switches with 2 to 5 positions per pole. Two-sided termination is standard for switches with 6 thru 10 positions per pole.



PC BOARD MOUNTING PATTERN

Shown for a two deck switch



SHAFT AND PANEL SEAL—Srs. 42 & 44

Standard Style

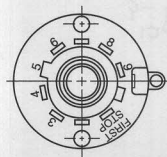
The Series 42/44 Styles, which include the letter "S" with the exception of style "HS", are watertight sealed to the mounting panel by utilizing the panel seal kit. These switches are built with a front plate that does not have a non-turn tab. The panel seal kit consists of a grooved hex nut, a keyed washer and a keyed panel seal. The grooved hex nut is assembled to the switch bushing. The keyed washer is slid down the bushing slot and seated into the hex nut groove. The seal is likewise assembled to the bushing and hex nut. The keyed washer is required to provide seal integrity in the bushing slot. When assembled to the panel, the grooved nut, backing washer and seal require the same space as a normal mounting nut. Hence, the seal kit does not alter the dimensions. Panel seal kit includes a non-turn washer to be used into a blind hole in the back panel. For panel seal kit part dimensions, see Page F-58. Style "HS" switches use a similar sealing method, except the integral assembly nut retains the panel seal. All sealed style switches are provided with a shaft to bushing internal seal.

ADJUSTABLE STOP SWITCHES—Series 42 and 44

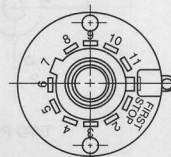
The standard and UL recognized switches are also available with adjustable stops. Two removable stop washers allow you to limit the number of switch positions as needed. A knurled nut is supplied to secure the washers if desired. These switches have no bushing keyway. All other dimensions, ratings and characteristics are the same as the standard fixed stop styles. Although not military qualified, the adjustable styles are useful in military equipment prototypes. However, when submitting the equipment for government approval, the fixed stop qualified style should be substituted.

See additional adjustable stop switch information at the beginning of the Rotary Switch section. For ordering information, see page F-58.

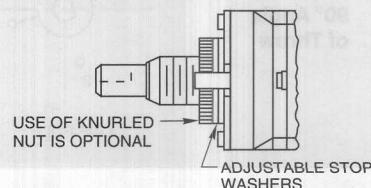
Front Views



Series 42



Series 44



Equivalent Styles

For style 42A36, use 42D36
For style 44A30, use 44D30
For style 42M36, use 42D36 initially
For style 44M30, use 44D30 initially
For style 42U36, use 42UD36
For style 44U30, use 44UD30

See pages F-55 through F-58 for specifications, accessories and ordering information.

1" DIAMETER, 1 AMP ROTARY SWITCHES

SERIES 43 AND 54—CONCENTRIC SHAFTS

FEATURES

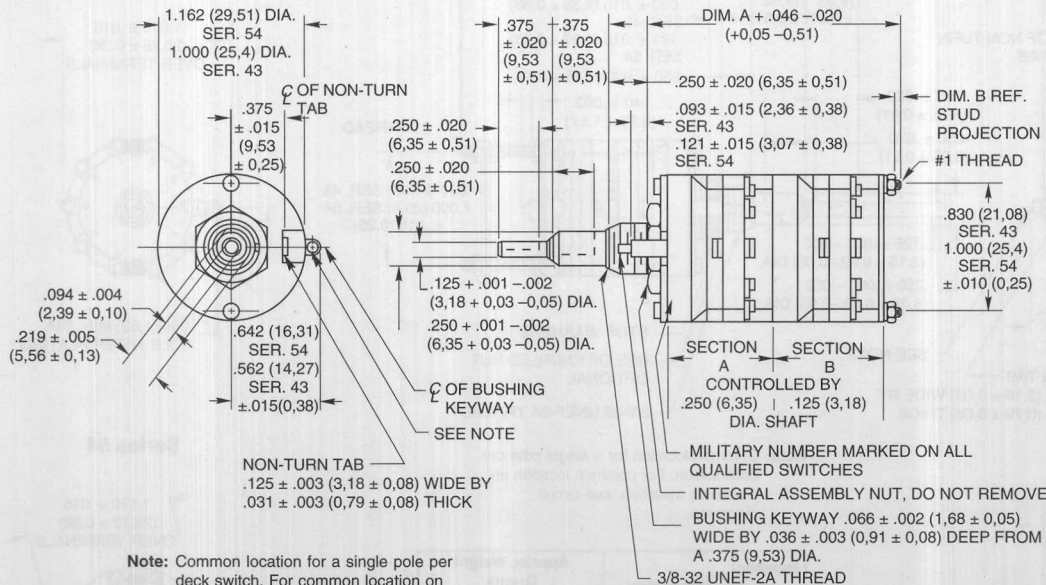
- Two Switches in the Panel Space of a Single Shaft Rotary
- Military Qualified Versions MIL-3786/04
- Choice of 10 Positions (Series 43) or 12 Positions (Series 54)



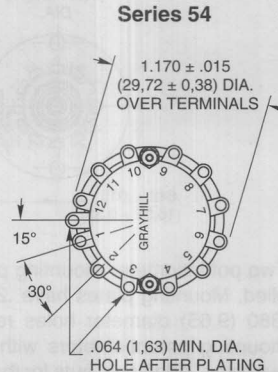
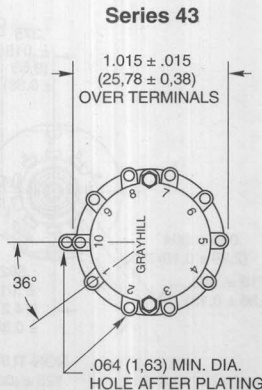
DIMENSIONS

Standard Style and Military Qualified

Rear Views



Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.



Number of Decks		Dimension A	Dimension B		Approx. Weight Grams	
Section "A"	Section "B"		Style A, M or H	Style M or H	Series 43	Series 54
1	1	1.818 (46,18)	.062 (1,57)	.030 (0,76)	48	60
2	1	2.164 (54,97)	.062 (1,57)	.030 (0,76)	54	67
3	1	2.510 (63,75)	.062 (1,57)	.280 (7,11)	60	74
1	2	2.164 (54,97)	.062 (1,57)	.030 (0,76)	54	67
2	2	2.510 (63,75)	.062 (1,57)	.280 (7,11)	60	74
3	2	3.105 (78,87)	.312 (7,92)	.280 (7,11)	66	81
1	3	2.510 (63,75)	.062 (1,57)	.280 (7,11)	60	74
2	3	3.105 (78,87)	.312 (7,92)	.280 (7,11)	66	81
3	3	3.451 (87,66)	.312 (7,92)	.280 (7,11)	72	88

Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

See page F-50 circuit diagrams, 1 pole/deck, 10 and 12 positions; 2 poles/deck, 12 positions.

See pages F-55 through F-58 for specifications, accessories and ordering information.

1" DIAMETER, 1 AMP ROTARY SWITCHES

**SERIES 43 AND 54-ADD-A-POT
STANDARD STYLE**

FEATURES

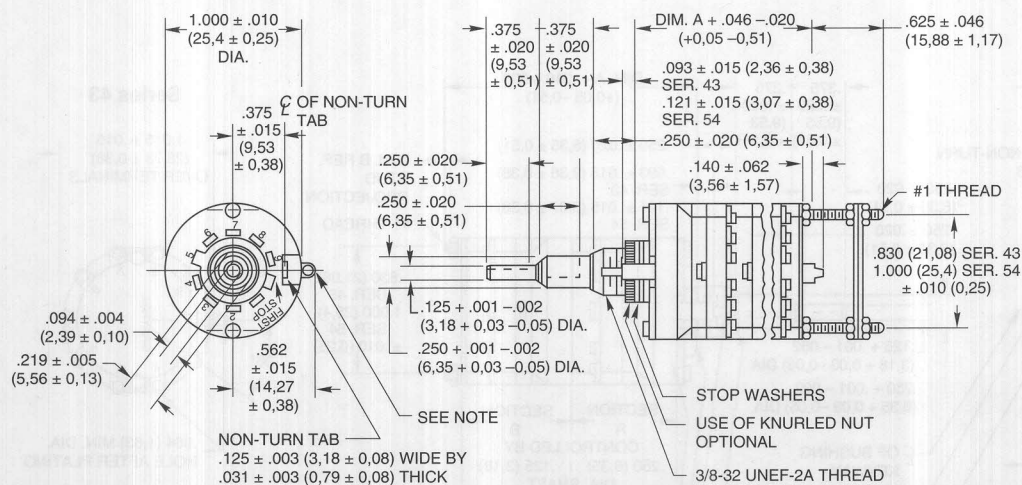
- Central Shaft Designed to Operate an Add-On Potentiometer
- Potentiometer Mounting Plates Provided
- Adjustable Stop Standard, Fixed Stop by Order
- Choice of 10 Positions (Series 43) or 12 Positions (Series 54)



DIMENSIONS In inches (and millimeters)

Standard Style

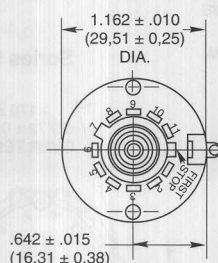
Series 43



Note: Common location for a single pole per deck switch. For common location on multi-pole switches, see circuit diagrams.

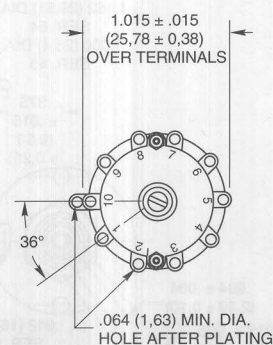
Number of Decks	Dimension A	Approx. Weight Grams	
		Series 43	Series 54
1	.974 (24,74)	48	60
2	1.320 (33,53)	54	67
3	1.666 (42,32)	60	74

Series 54

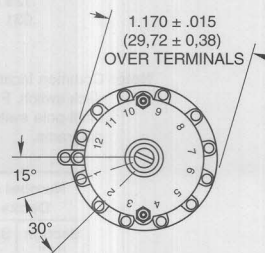


Rear Views

Series 43



Series 54



Two potentiometer mounting plates are supplied. Mounting plates have .261 (6.63) and .380 (9.65) diameter holes respectively for mounting potentiometers with 1/4" and 3/8" bushings. Additional nuts for the through bolts of the switch are provided for adjustment of mounting plate location. Tapered tongue on 1/8" shaft provides coupling to screwdriver slots in potentiometer shafts.

Plated brass spacers for ease of positioning mounting plate driving assembly are available on special request (sold only with switches). The use of spacers is recommended for other than prototype requirements. When ordering switches with spacers, give full details regarding special length, potentiometer being used, etc.

Standard style, concentric shaft, add-a-pot switches have adjustable stops. See Adjustable Stop description. Fixed stop types are also available, see Standard Options page F-10.

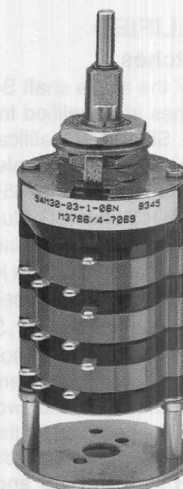
Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

See page F-50 circuit diagrams, 1 pole/deck, 10 and 12 positions; 2 poles/deck, 12 positions.

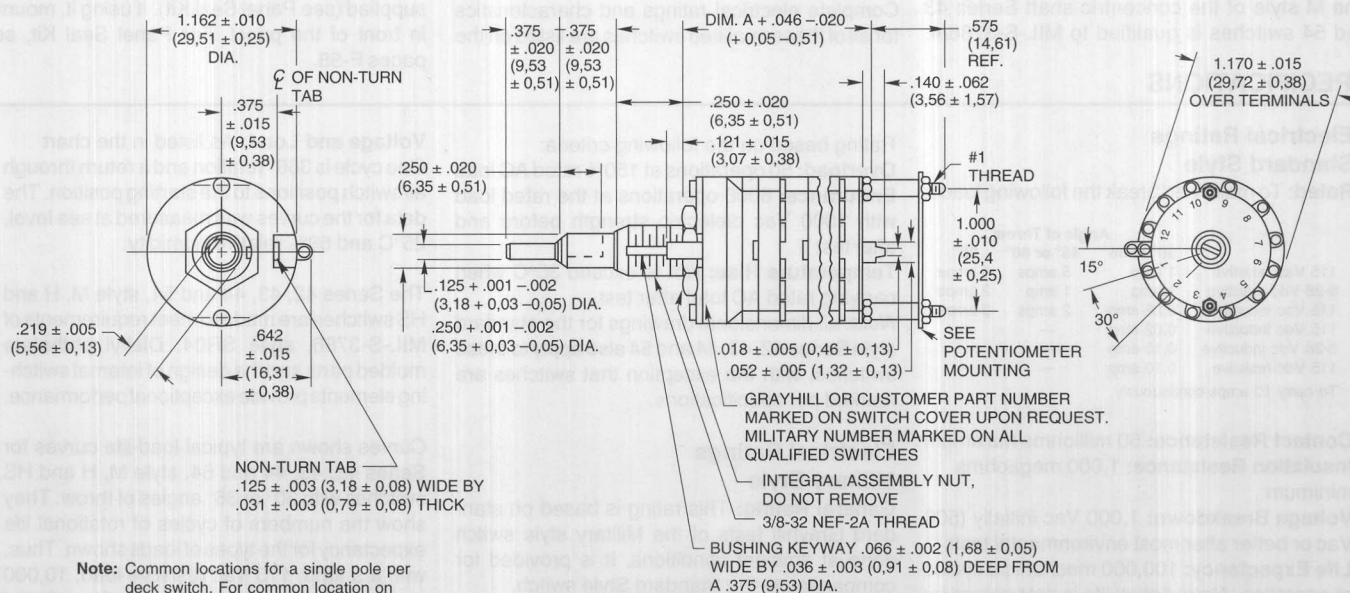
See pages F-55 through F-58 for specifications, accessories and ordering information.

DIMENSIONS In inches (and millimeters)

- Military Qualified MIL-3786/04
- Central Shaft Designed to Operate MIL Potentiometer
- Mounting Plate Options Provide Choice of Potentiometer
- Fixed Distance from Switch to Mounting Plate



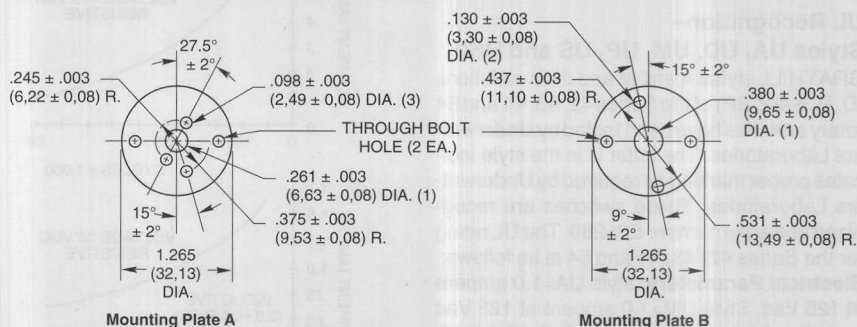
Military Qualified Style



Number of Decks	Dimension A	Approximate Weight Grams
1	1.024 (26,01)	60
2	1.370 (34,80)	67
3	1.716 (43,59)	74

Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

The two mounting plates shown below are supplied with each switch.



See page F-50 circuit diagrams, 1 pole/deck, 12 positions.

See pages F-55 through F-58 for specifications, accessories and ordering information.

1" DIAMETER, 1 AMP ROTARY SWITCHES

MILITARY QUALIFIED

Single Shaft Switches

The military styles of the single shaft Series 42 and 44 rotary switches are qualified to MIL-S-3786/4, specifically SR04-1. Qualification includes two temperature ranges. Unsealed styles M, MB, MG and MBG are qualified for -65 to 85°C. Unsealed styles H, HB, HG and HBG, plus sealed styles HS, HBS, HGS and HBGS are qualified for -65°C to 125°C. Qualification includes low level switching and shaft grounding as specified in MIL-S-3786. Qualification includes 30°, 36°, 45°, 60° and 90° angles of throw with solder lug terminals. The military styles are dimensionally the same as the standard styles with two exceptions. The location of the common for the 3-pole switch differs (see circuit diagrams), and the non-turn tab for styles HS, HBS, HGS and HBGS differs per the Shaft and Panel Seal description following.

Two Switches, Concentric Shafts

The M style of the concentric shaft Series 43 and 54 switches is qualified to MIL-S-3786/4,

specifically SR04-2. Unsealed switches are qualified for -65°C to 85°C in 30°, 36°, 45°, 60° and 90° throws. The standard and military styles of the concentric switches have the same dimensions with the exception of the location of the 3 pole common (see circuit diagrams). The 30° and 36° throws are described in the ordering information. If the 45°, 60° and 90° throws are required, they can be provided in Section A of the Series 54 Rotary Switches; see Standard Options, page F-10.

Add-A-Pot Switches

The military style of the add-a-pot Series 54 switch is qualified to MIL-S-3786/4, specifically SR04-3. These unsealed switches are qualified for -65°C to 85°C in 30°, 45°, 60° and 90° throws. The dimensions of the military style add-a-pot switches are not the same as the standard add-a-pot switches; see drawings.

All Qualified Switches

Complete electrical ratings and characteristics for all of these qualified switches are listed on the

following pages. Standard variations such as terminals, shaft and/or bushing length etc., which do not affect performance, can be marked as qualified product. Adjustable stops cannot be qualified. Contact GRAYHILL for details about variations.

Military qualified switches may be ordered by the military M number listed in MIL-S-3786/4 or by the GRAYHILL part number. They will be marked to specifications.

MILITARY QUALIFIED SHAFT AND PANEL SEAL—

Styles HS, HBS, HGS and HBGS

The shaft is sealed to the bushing by an internal O-ring per MIL-P-5516B. The bushing is sealed to the panel with a silicone rubber washer and a stainless steel backing washer. The combined uncompressed thickness is 0.055" (1.40). Since this switch has a flat cover, a non-turn washer is supplied (see Panel Seal Kit). If using it, mount it in front of the panel. For Panel Seal Kit, see pages F-58.

SPECIFICATIONS

Electrical Ratings

Standard Style

Rated: To make and break the following loads:

	Angle of Throw		
	30° or 36°	45° or 60°	90°
115 Vac resistive	1 amp	5 amps	5 amps
6-28 Vdc resistive	1 amp	1 amp	2 amps
115 Vac inductive	0.25 amp	2 amps	2 amps
115 Vdc inductive	0.02 amp	—	—
6-28 Vdc inductive	0.10 amp	—	—
115 Vdc resistive	0.10 amp	—	—

To carry 10 amps continuously.

Contact Resistance: 50 milliohms maximum

Insulation Resistance: 1,000 megaohms minimum

Voltage Breakdown: 1,000 Vac initially (500 Vac or better after most environmental tests)

Life Expectancy: 100,000 mechanical cycles of operation. *Note:* Actual life is determined by a number of factors, including electrical loading, rate of rotation, and environment, as well as maximum voltage breakdown required at the end of life.

UL Recognition—

Styles UA, UD, UM, UP, US and USP

GRAYHILL styles A and M and their variations (D, P, S and SP) of the Series 42, 43, 44 and 54 rotary switches have been tested by Underwriters Laboratories. The letter U in the style indicates proper marking as required by Underwriters Laboratories. These switches are recognized under file number E35289. The UL rating for the Series 42, 43, 44 and 54 is as follows:

Electrical Parameters: style UA=1.0 ampere at 125 Vac. Style UM=1.0 ampere at 125 Vac and also .5 ampere at 125 Vac, inductive load, 0.75 to 0.8 power factor.

Rating based on the following criteria:

Overload: 50 operations at 150% rated AC load

Endurance: 6000 operations at the rated load with 1000 Vac dielectric strength before and after test

Temperature Rise: Not to exceed 30°C when carrying rated AC load after test.

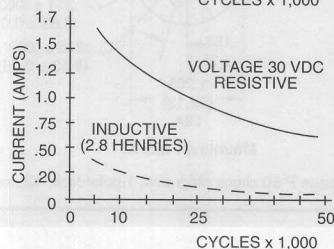
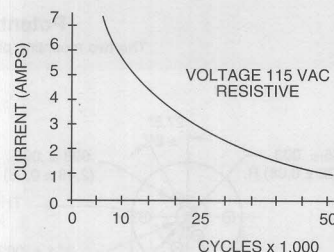
Note: all dimensional drawings for the standard style Series 42, 43, 44 and 54 also apply to these switches, with the exception that switches are marked per specifications.

Electrical Ratings

Military Style

General Rating: This rating is based on standard Grayhill tests of the Military style switch done at ambient conditions. It is provided for comparison to the Standard Style switch.

Charts shown for non-shorting contacts (break before make)



Voltage and Load: As listed in the chart

One cycle is 360° rotation and a return through all switch positions to the starting position. The data for the curves was measured at sea level, 25°C and 68% relative humidity.

The Series 42, 43, 44 and 54, style M, H and HS switches are made to meet requirements of MIL-S-3786, style SR04. Diallyl phthalate molded parts and the design of internal switching elements provide exceptional performance.

Curves shown are typical load-life curves for Series 42, 43, 44 and 54, style M, H and HS switches with 30° or 36° angles of throw. They show the numbers of cycles of rotational life expectancy for the types of loads shown. Thus, with a 5 amp, 115 Vac resistive load, 10,000 cycles of life is expected. If the load is reduced to 3 amps, life is increased to 25,000 cycles. The larger angles of throw (45°, 60° or 90°) switch larger currents for a like number of cycles.

Life limiting or failure criteria for these curves are:

Contact Resistance: 50 milliohms maximum

Insulation Resistance: 1,000 megaohms minimum between mutually insulated parts

Voltage Breakdown: 1,000 Vac minimum between mutually insulated parts. These switches will carry 10 amps with maximum contact temperature rise of 20°C. Life can be predicted by GRAYHILL if less critical life characteristics, elevated temperature or reduced pressure is involved.

1" DIAMETER, 1 AMP ROTARY SWITCHES

SPECIFICATIONS

MIL-S-3786 Electrical Values Military Style

Style M switches, at 85°C, approximately 68% humidity and sea level pressure and style H and HS at 125°C have been tested to make and break the following loads as stated in MIL-S-3786/SR04; 250 milliamperes at 28 Vdc resistive, 100 milliamperes at 28 Vdc inductive (2.8 henries); 75 milliamperes at 115 Vac resistive.

These switches have also been tested at reduced barometric pressure (70,000 feet), 25°C at approximately 68% relative humidity to make and break the following loads as stated in MIL-S-3786/SR04; 200 milliamperes, 28 Vdc resistive; 25 milliamperes, 28 Vdc inductive (2.8 henries); 20 milliamperes, 115 Vac resistive. When tested to these loads and conditions the style M, H and HS switches meet the following life limiting or failure criteria after 25,000 cycles in accordance with MIL-S-3786.

Contact Resistance: 50 milliohms maximum

Insulation Resistance: 1,000 megaohms minimum between terminals and shafts

Dielectric Strength: 1,000 Vac (atmospheric pressure) and 450 Vac (reduced pressure) minimum between mutually insulated parts.

When tested at sea level 25°C and 68% relative humidity with failure criteria of 50 milliohms max. and 750 Vac breakdown voltage, these switches will make and break the following loads: 250 mA at 28 Vdc, inductive (2.8 henries); 1.25 amps at 28 Vdc resistive; 2.0 amps at 115 Vac, 60 Hz resistive, for 10,000 cycles.

These switches also meet MIL-S-3786/SR04 for moisture resistance, medium and high shock, vibration (10 to 2000 cps), thermal shock (-65°C to 125°C), salt spray, explosion and terminal pull.

Materials and Finishes Standard Style

Bases: Melamine per MIL-M-14,4

Cover, Deck Separators, End Plate and Rotor Mounting Plate: Phenolic per MIL-M-14

Mounting Bushings and Nuts: Brass, Cadmium plated per QQ-P-416, Class 2, Type II

Shaft Cover Plate, Retaining Rings, Through Bolts, Shaft Extensions, Stop Arm, Stop Washers and Rear Support Plate: Stainless Steel

Detent Balls: Steel, Nickel plated

Detent Springs: Tinned music wire

Rotor Contact, Stator (Base) Contacts: Silver alloy

Terminals (Except Common): Brass, lead-tin plated and fused

Common Plate, Including Solder Lug: Brass, Silver plated .0003" minimum

Mounting Hardware: Two mounting nuts .094" (2,39) thick by .562" (14,27) across flats and one internal tooth lockwasher are supplied with each switch.

Materials and Finishes Military Qualified

Bases: Diallyl per MIL-M-14

Cover, Deck Separators, End Plate and Rotor Mounting Plate: Diallyl per MIL-M-14

Mounting Bushings and Nuts: Brass, Cadmium plated per QQ-P-416, Class 2, Type II

Shaft Cover Plate, Retaining Rings, Through Bolts, Shaft Extensions, Stop Arm, Stop Washers and Rear Support Plate: Stainless Steel

Detent Balls: Steel, Nickel plated

Detent Springs: Tinned Music Wire

Rotor Contact: Silver Alloy

Terminals, Common Plate Including Solder Lug: Brass, Silver plated .0003" minimum

Mounting Hardware: Two mounting nuts .094" thick by .562" across flats and one internal tooth lockwasher are supplied with each switch.

Additional Characteristics

Standard Style and Military Qualified

Contact: Shorting or non-shorting wiping contacts with over 150 grams of contact force

Rotational Torque: 8-115 ounce-inches depending upon the number of poles per deck, number of decks and angle of throw

Mechanical Life Expectancy: 100,000 cycles of operation

Shaft Flat Orientation: Flat opposite contact position of pole number one (See circuit diagram).

Stop Strength: For Standard style: 15 pound-inches minimum. For Adjustable Stop styles: 12 pound-inches

Extended Stud: Single shaft switches of six or more decks and concentric shaft switches of a combination of five or more decks (Standard style) or four or more decks (Military style) have longer studs with extra mounting nuts for recommended double end mount.

1" DIAMETER, 1 AMP ROTARY SWITCHES

CHOICES AND LIMITATIONS—Series 42, 43, 44 and 54

A = Standard, Solder Lugs
P = Standard, PC Mount Terminals
D = Standard, Adjustable Stops

S = Shaft and Panel Seal
U = UL Recognized
M = Military Qualified 85°C⁴

H = Military Qualified, 125°C
B = Military, Grounded Shaft
G = Military, Low Level Rating

Single Shaft Switches

Series	Style Choices	Angle of Throw	Number of Decks	Poles Per Deck	Positions Per Pole ^{1,3}	Shorting or Non-Shorting
42	Unsealed	36°	01 thru 12 01 thru 12	1 2	02 thru 10 ³ 02 thru 05	N or S N or S
44	A UA UM ⁵ M MB MG MBG H HB HG HBG	30°	01 thru 12 01 thru 12 01 thru 08 01 thru 06 01 thru 04 01 thru 04	1	02 thru 12 ³	N or S
				2	02 thru 06	N or S
				3	02 thru 04	N or S
				4	02 or 03	N or S
				5	02	N or S
				6	02	N or S
		45°	01 thru 12 01 thru 06 01 thru 04 01 thru 03	1	02 thru 08 ³	N or S
				2	02 thru 04	N or S
				3	02	N
				4	02	N
		60°	01 thru 12 01 thru 06 01 thru 04	1	02 thru 06 ³	N
				2	02 or 03	N
				3	02	N
		90°	01 thru 12 01 thru 06	1	02 thru 04 ³	N
				2	02	N
44	D UD	30°	01 thru 12 01 thru 12 01 thru 08 01 thru 06	1	AJ (2 thru 12) ¹	N or S
				2	AJ (2 thru 6) ¹	N or S
	42	36°	01 thru 12 01 thru 12	3	AJ (2 thru 4) ¹	N or S
				4	AJ (2 or 3) ¹	N or S
	P UP	36°	01 thru 12 01 thru 12	1	AJ (2 thru 10) ¹	N or S
				2	AJ (2 thru 5) ¹	N or S
42	P UP	36°	01 thru 12	1	02 thru 10 ³	N or S

Concentric Shaft Switches

Series	Style Choices	Angle of Throw	Decks	Section A (Front)			Section B (Rear)			
				Poles	Position	N or S	Decks	Poles	Position	N or S
CONCENTRIC SHAFT, 2 SWITCHES										
54	A ² UA ² M ²	30°	01 thru 03	1	02 thru 12 ³	N or S	01 thru 03	1	02 thru 12 ³	N or S
			01 thru 03	2	02 thru 06	N or S	01 thru 03	2	02 thru 06	N or S
							01 or 02	3	02 thru 04	N or S
							01	4	02 or 03	N or S
							01	5	02	N or S
							01	6	02	N or S
43		36°	01 thru 03	1	02 thru 10 ⁵	N or S	01 thru 03 01 thru 03	1 2	02 thru 10 ³ 02 thru 05	N or S N or S
ADD-A-POT SWITCHES										
54	D UD	30°	01 thru 03 01 thru 03	1 2	AJ (2-12) ¹ AJ (2-6) ¹	N or S N or S	Second shaft operates a potentiometer supplied by the customer. Rear mounting plates are provided.			
43		36°	01 thru 03	1	AJ (2-10) ¹	N or S				
54	M	30°	01 thru 03 01 thru 03	1 2	02 thru 12 ⁵ 02 thru 06	N or S N or S				

¹For Adjustable Stop (with the letter D), use AJ instead of number of positions when ordering.

²For 45°, 60° or 90° throws in Series 54 switches of these styles, see Standard Options.

³For single pole switches with the maximum positions per pole, continuous rotation is possible. Specify fixed stop or continuous rotation when ordering single shaft switches. Concentric shaft switches have continuous rotation.

⁴Styles which include both M and S are not qualified but are made of the same materials and construction as qualified types. For qualified switches with shaft and panel seal, use equivalent HS style.

⁵UM switches are made of the same materials and construction as the M style switches. For military switch UM is not required; use M style.

STANDARD OPTIONS

Terminals, military qualified shielding, additional angles of throw, etc., see Options, pages F-9 and F-10.

ADDITIONAL FEATURES

For single shaft switches with spring return, isolated positions, keylocks, see the Features Selection Chart, page F-7.

ACCESSORIES

Internal Tooth Lockwasher—Figure A

For a $\frac{3}{8}$ " bushing. Approximately 0.500" (12,7) outside diameter, .022" (0,56) thickness. Material is cadmium plated steel. **Part No. 12Q1272-1**
For a $\frac{1}{4}$ " bushing. Approximately 0.400" (10,16) outside diameter, .018" (0,46) thickness. Material is passivated stainless steel. **Part No. 8J1026**



FIGURE A

Non-Turn Washer—Figure B

Can be ordered as extra hardware for the Series 5000, 24, 42, 43, 44, 54, 71B, 53, 57 and 59 rotary switches. The internal key of the washer slides into the bushing keyway. The right angle tab locks into a pre-drilled hole on the back side of the mounting panel. Material is brass, cadmium plates. **Part No. 12C1087-1**

Panel Seal Kit—Figure C

Sold as a separate item to seal the switch

bushing to the panel. The kit consists of four items: a grooved hex nut, a keyed washer, a keyed seal and a non-turn washer. Assembly is described on Page F-51. Dimensions of panel seal kit items are shown in Figure C. This kit seals the bushing to the panel; it does not seal the shaft to the bushing. Not usable with adjustable stop switches. **Part No. 42-24**

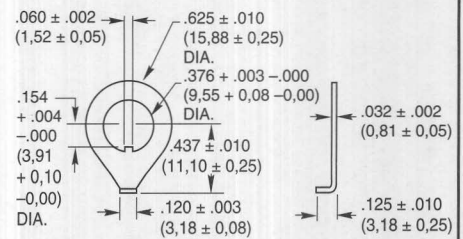


FIGURE B

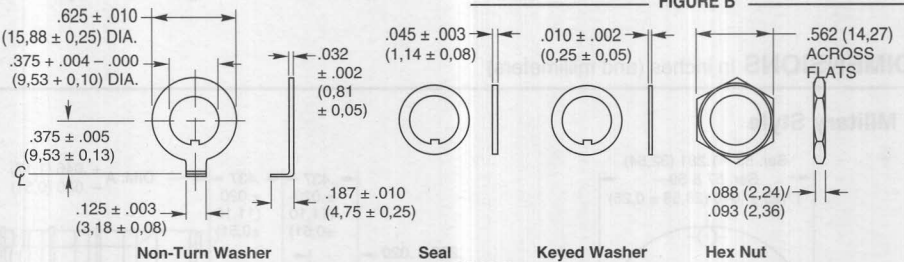
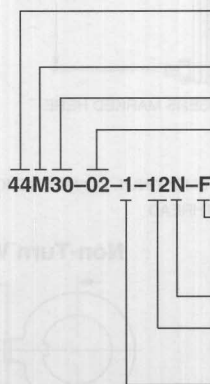


FIGURE C

ORDERING INFORMATION—Single Shaft Switches, Add-A-Pot Switches



Series: Determined by the type of switch and the angle of throw

Style: Letter(s) from the Choices and Limitations chart

Angle of Throw: Must agree with Series Number

Number of Decks: As limited by the angle of throw, the poles per deck, switch style, and type of contacts

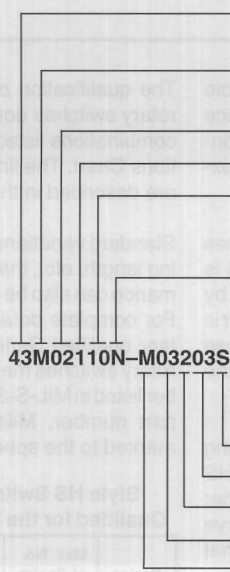
Stop Arrangement: Add letter F to a one pole per deck switch with the maximum number of positions for a stop between position 1 and the last position. Leave blank for continuous rotation

Type of Contacts: N = Non-shorting; S = Shorting

Positions Per Pole: Requires 02 positions as a minimum to maximum allowable dependent on the angle of throw, and poles per deck. Use AJ for adjustable stops (Styles D and UD).

Poles Per Deck: As limited by angle of throw, switch series and style

ORDERING INFORMATION—Concentric Shaft Rotary Switches



Series: Determined by the angle of throw, applicable to both sections

Style: Letter(s) from the Choices and Limitations chart

Section A (front)

Number of Decks: As limited by the number of poles per deck

Poles Per Deck: As limited by the angle of throw

Positions Per Pole: Requires 02 positions as a minimum to the maximum allowable dependent on the angle of throw and the poles per deck

Type of Contacts: N=Non-shorting, S=Shorting. All one pole per deck switches with the maximum number of positions are continuous rotation

Section B (rear)

The limitations listed for Section A apply to Section B

Type of Contacts

Positions Per Pole

Poles Per Deck

Number of Decks

Style

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

16, 20 AND 24 POSITION ROTARY SWITCHES

SERIES 53, 57 AND 59

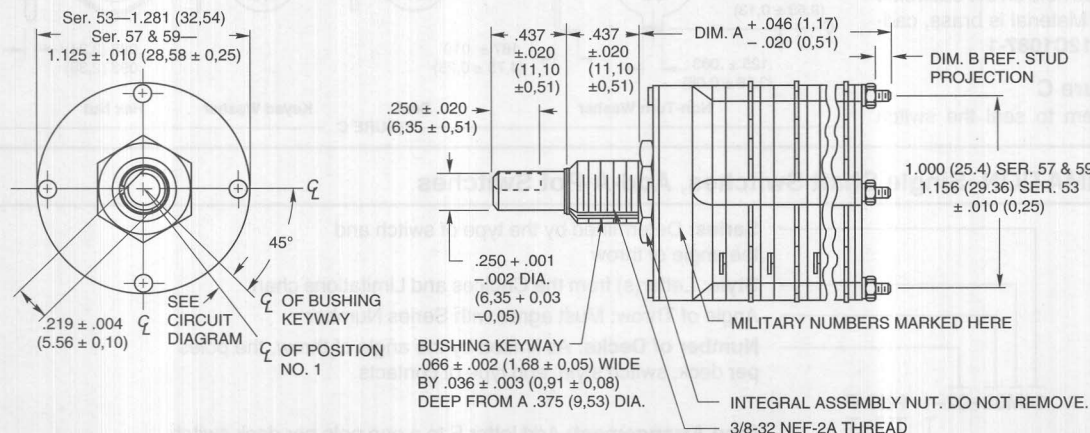
FEATURES

- Smallest Diameter Rotary Switch With This Number of Positions and Current Capacity
- Military Qualified MIL-S-3786/36
- Gold Plated Contact System Compatible with Logic Circuitry



DIMENSIONS In inches (and millimeters)

Military Style

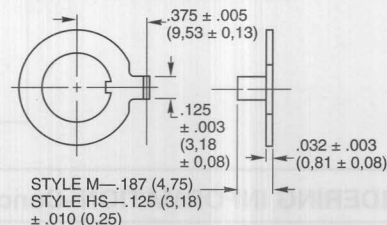


No. of Decks	Dimension A	Dimension B	Approx. Weight Grams	No. of Decks	Dimension A	Dimension B	Approx. Weight Grams
1	.916 (23,27)	.032 (0,81)	50	7	3.164 (80,37)	.281 (7,14)	110
2	1.249 (31,72)	.032 (0,81)	60	8	3.497 (88,82)	.281 (7,14)	120
3	1.582 (40,18)	.032 (0,81)	70	9	3.830 (97,28)	.281 (7,14)	130
4	1.915 (48,64)	.032 (0,81)	80	10	4.163 (105,74)	.281 (7,14)	140
5	2.248 (57,10)	.032 (0,81)	90	11	4.496 (114,20)	.281 (7,14)	150
6	2.831 (71,91)	.281 (7,14)	100	12	4.829 (122,66)	.281 (7,14)	160

Mounting Hardware: Two mounting nuts, .094" (2,39) thick by .562" (14,27) across flats, one internal tooth lockwasher and one non-turn washer (see detail D for dimensions), are supplied with switch.

Grayhill part number and date code marked on detent cover label. Customer part number marked on request. Military part number marked when required.

Non-Turn Washer Detail D



STANDARD STYLE MILITARY QUALIFIED

The Series 53, 57 and 59 rotary switches are all military type switches. GRAYHILL manufactures these switches in two styles: M and HS. Style M is unsealed and is *not* qualified; Style HS is shaft and panel sealed and *is* qualified. The non-qualified Style M can be regarded as our Standard Style for types of switches. Although it is not qualified, Style M is constructed of the same military grade materials and will provide comparable performance in all areas. For example, the Style 'M' switches, in addition to the electrical ratings listed elsewhere in these pages, will meet the following requirements of MIL-S-3786: Moisture Resistance: Medium and High Shock; Vibration (10 to 500 cps); Thermal Shock (-65 °C to 125 °C); Salt Spray; Explosion; Terminal Strength (pull, 2 lbs. minimum); and Stop Strength (15 pound-inches minimum).

The line drawings shown above are applicable to the Style M and Style HS. The only difference between the two is the length of the tab of the non-turn washer. The shorter tab for the HS is explained in the following paragraph.

The Series 53, 57 and 59 Style HS rotary switches are qualified to MIL-S3786/36. The Style HS is shaft and panel sealed. The panel is sealed by an O-ring at the base of the bushing. The shaft is sealed by an O-ring inside the bushing. These seals do not alter the dimensions shown in the line drawings when the switch is mounted.

A non-turn washer, supplied with the mounting hardware, may be used with the Style HS switches. It is suggested that the non-turn washer be mounted in the following manner to preserve the seal: from the front of the panel into a hole that does not go through the panel.

The qualification of the Series 53, 57 and 59 rotary switches does not extend to all possible combinations listed in the Choices and Limitations Chart. The limitations on the qualification are described in the chart shown below.

Standard variations, such as shaft and/or bushing length, etc., that do not affect switch performance can also be marked as qualified product. For complete details contact GRAYHILL. Military qualified Series 53, 57 and 59 Style HS rotary switches may be ordered by the 'M' number listed in MIL-S-3786/36, or by the GRAYHILL part number. Military style switches will be marked to the specification.

Style HS Switches are MIL-S-3786/36 Qualified for the Following Characteristics

Series	Max. No. of Decks	Max. No. Poles/Deck	Max. No. Total Poles/Switch
53	5	8	24
57	5	4	20
59	5	5	20

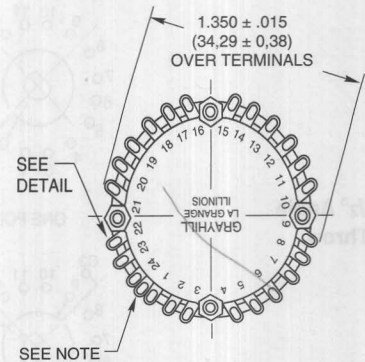
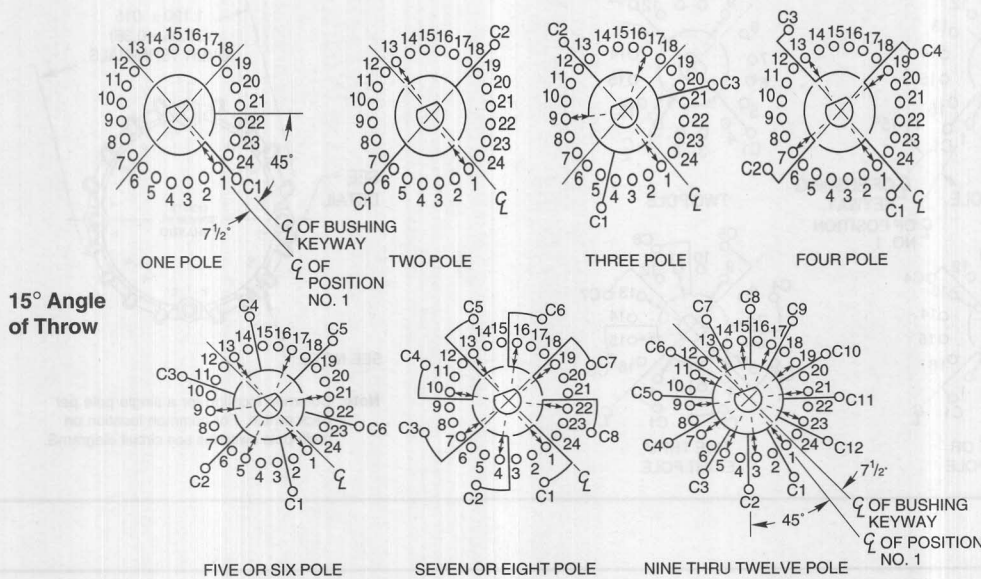
16, 20 AND 24 POSITION ROTARY SWITCHES

CIRCUIT DIAGRAMS—Series 53

Switch is Viewed From Shaft End and Shown in Position No. 1

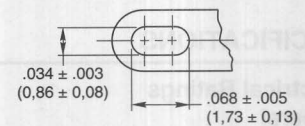
Note: All common terminals are located above base terminals as shown.

Rear View



Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

Terminal Detail

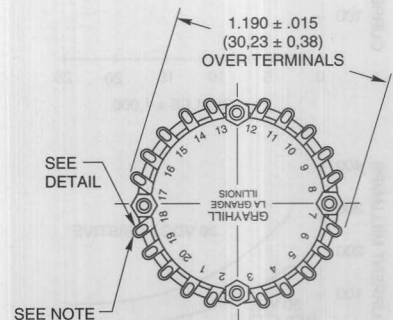
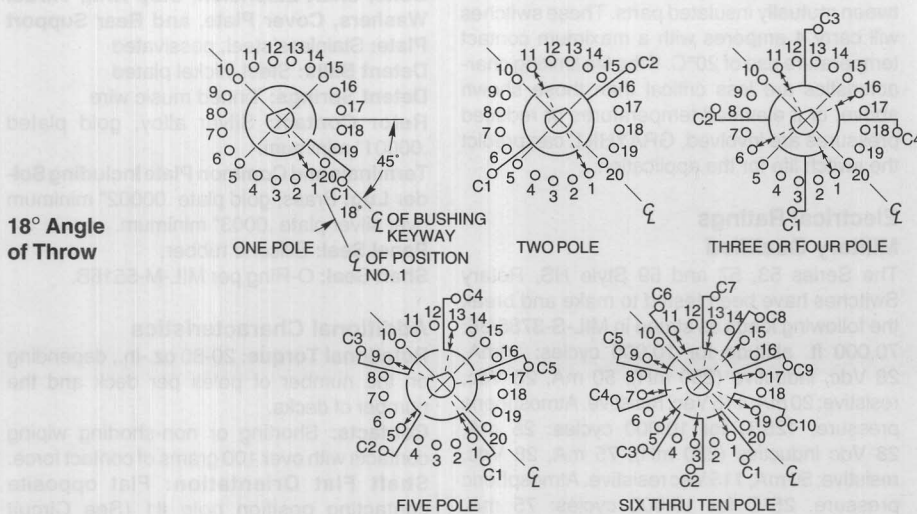


CIRCUIT DIAGRAMS—Series 59

Switch is Viewed From Shaft End and Shown in Position No. 1

Note: All common terminals are located above base terminals as shown.

Rear View



Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

See following page for Series 57, 22 1/2° angle of throw circuitry.

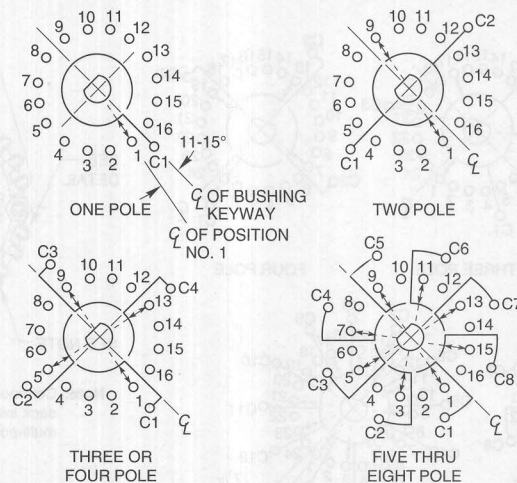
16, 20 AND 24 POSITION ROTARY SWITCHES

CIRCUIT DIAGRAMS—Series 57

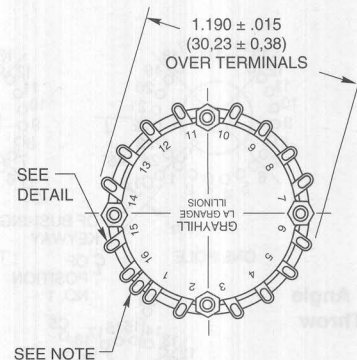
Switch is Viewed From Shaft End and Shown in Position No. 1.

Note: All common terminals are located above base terminals as shown.

22½° Angle
of Throw



Rear View



Note: Common location for a single pole per deck switch. For common location on multi-pole switches see circuit diagrams.

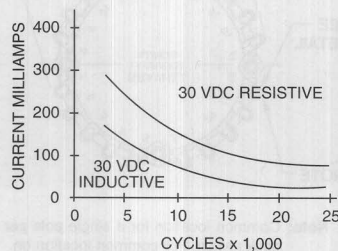
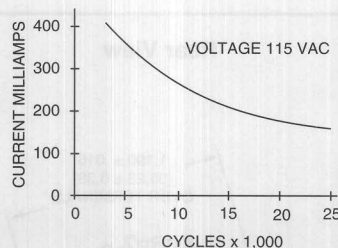
SPECIFICATIONS

Electrical Ratings

General

Switch rating for break before make contacts.

Voltage: As listed in the chart.



Curve data based on test data conducted at sea level, 25°C and relative humidity. Cycle equals 360° rotation and 360° return. Cycling rate is 10 cycles per minute. The curves shown are typical load life curves for a Series 53M, 57M and 59M Rotary Switch. They show the number of cycles of rotational life that can be expected for the voltages, currents and types

of loads shown. Thus, with a 250 milliampere, 30 Vdc resistive load, 10,000 cycles of life can be expected. Life limiting or failure criteria for these curves are:

Contact Resistance: 50 milliohms maximum (20 milliohms initially).

Insulation Resistance: 1,000 megohms minimum between mutually insulated parts.

Voltage Breakdown: 500 Vac minimum between mutually insulated parts. These switches will carry 4 amperes with a maximum contact temperature rise of 20°C. If the life limiting characteristics are less critical than those shown above, or if elevated temperatures or reduced pressures are involved, GRAYHILL can predict the switch life for the application.

Electrical Ratings Military Qualified

The Series 53, 57 and 59 Style HS, Rotary Switches have been tested to make and break the following loads as stated in MIL-S-3786/36: 70,000 ft. altitude for 10,000 cycles: 10mA, 28 Vdc, inductive (250 mH); 50 mA, 28 Vdc, resistive; 20 mA, 115 Vac, resistive. Atmospheric pressure, 125°C for 10,000 cycles: 25 mA, 28 Vdc inductive (250 mH); 75 mA, 28 Vdc, resistive; 50 mA, 115 Vac resistive. Atmospheric pressure, 25°C for 10,000 cycles: 75 mA, 28 Vdc, inductive (250 mH); 250 mA, 28 Vdc resistive; 150 mA, 115 Vac, resistive. Life limiting criteria for these loads are:

Contact Resistance: 50 milliohms maximum.

Dielectric Strength: 500 Vac (350 Vac—reduced pressure).

Insulation Resistance: 1,000 megohms minimum. These switches also meet MIL-S-3786/36 for moisture resistance, medium and high shock,

vibration, thermal, thermal shock, salt spray, explosion, terminal strength, and stop strength.

Materials and Finishes

Cover, Base, Spacer, and Rotor Mounting Plate: Diallyl per MIL-M-14

Mounting Bushing and Nuts: Brass Cadmium plated per QQP-416, Class 2, Type II.

Shaft, Stop Pins, Retaining Rings, Through Bolts, Shaft Extension, Stop Arm, Thrust Washers, Cover Plate, and Rear Support Plate: Stainless steel, passivated

Detent Balls: Steel, nickel plated

Detent Springs: Tinned music wire

Rotor Contact: Silver alloy, gold plated .00001" minimum.

Terminals and Common Plate Including Solder Lug: Brass, gold plate .00002" minimum over silver plate .0003" minimum.

Panel Seal: Silicone rubber.

Shaft Seal: O-Ring per MIL-M-5516B.

Additional Characteristics

Rotational Torque: 20-80 oz.-in., depending on the number of poles per deck and the number of decks.

Contacts: Shorting or non-shorting wiping contacts with over 100 grams of contact force.

Shaft Flat Orientation: Flat opposite contacting position pole #1 (See Circuit Diagrams).

Extended Studs: Switches of 6 decks or more have longer studs with extra stud nuts for recommended double end mounting.

Terminals: Switch is provided with full complement of base or position terminals regardless of the number of active positions.

16, 20 AND 24 POSITION ROTARY SWITCHES

CHOICES AND LIMITATIONS

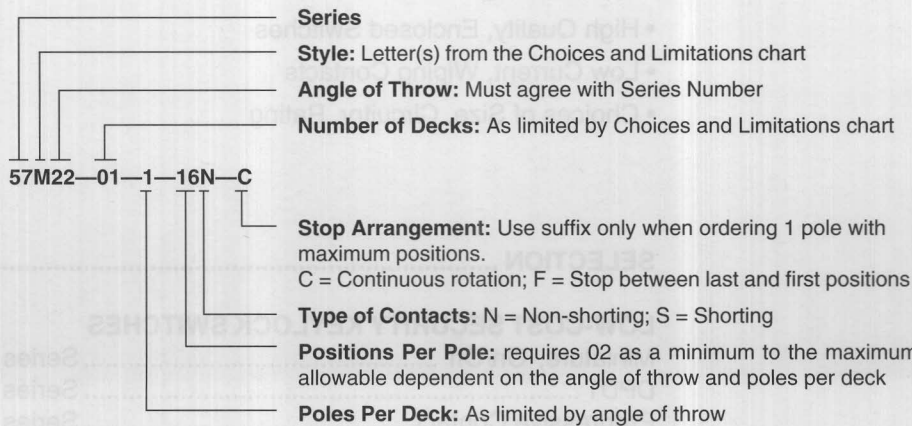
Series	Style and Designation	Angle of Throw	Stops	Terminals	Number of Decks		Poles Per Deck	Number of Positions/Pole
					Shorting	Non-Shorting		
53	M=Military Style HS=Military Qualified, Shaft/Panel Seal	15°	Fixed	Solder Lug	01 thru 12	01 thru 12	1	02 thru 24
					01 thru 12	01 thru 12	2	02 thru 12
					01 thru 08	01 thru 08	3	02 thru 08
					01 thru 06	01 thru 06	4	02 thru 06
					01 thru 04	01 thru 04	5 or 6	02 thru 04
					01 thru 03	01 thru 03	7 or 8	02 or 03
					01 or 02	01 or 02	9, 10, 11 or 12	02
57	M=Military Style HS=Military Qualified, Shaft/Panel Seal	22½°	Fixed	Solder Lug	01 thru 12	01 thru 12	1	02 thru 16
					01 thru 12	01 thru 12	2	02 thru 08
					01 thru 06	01 thru 06	3 or 4	02 thru 04
					01 thru 03	01 thru 03	5, 6, 7 or 8	02
59	M=Military Style HS=Military Qualified, Shaft/Panel Seal	18°	Fixed	Solder Lug	01 thru 12	01 thru 12	1	02 thru 20
					01 thru 12	01 thru 12	2	02 thru 10
					01 thru 06	01 thru 06	3 or 4	02 thru 05
					01 thru 04	01 thru 04	5	02 thru 04
					01 or 02	01 or 02	6, 7, 8, 9 or 10	02
					01 or 02	01 or 02		

MIL Spec provides for qualification up to and including five decks. Switches of longer length, although not specifically qualified, are built of the same materials and are of the same construction.

STANDARD OPTIONS

Terminals, shielding, additional angles of throw, etc. see Options, pages F-9 and F-10.

ORDERING INFORMATION



Available from your local Grayhill Distributor
 For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

CONTENTS: KEYLOCK ROTARY SWITCHES

CHOICES AND LIMITATIONS

Series	Style and Designation	Angle of Throw	Slope	Terminals	Coating	Number of Decks	Part No.	Position
58	HS-Military Qualified, Standard Seal	15°	Fixed	Solder Lug	01 thru 02 01 thru 03 01 thru 04 01 thru 08 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12
71	HS-Military Qualified, Standard Seal	25°	Fixed	Solder Lug	01 thru 02 01 thru 03 01 thru 04 01 thru 08 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12
88	HS-Military Qualified, Standard Seal	15°	Fixed	Solder Lug	01 thru 02 01 thru 03 01 thru 04 01 thru 08 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12	01 thru 12 01 thru 12 01 thru 12 01 thru 12 01 thru 12

ML Spec provides for qualification to include five decks. Switches of longer length, although not specifically qualified, are built to the same standards and are of the same construction.

STANDARD OPTIONS

Terminal wiring options are of three types: 1. Standard, 2. Special, 3. Custom. See Options pages F-9 and F-10.

ORDERING INFORMATION

KEYLOCK ROTARY SWITCHES

- Protection From Unauthorized Use
- Static Damage Protection
- High Quality, Enclosed Switches
- Low Current, Wiping Contacts
- Choices of Size, Circuitry, Rating

Page

SELECTION F-7

LOW-COST SECURITY KEYLOCK SWITCHES

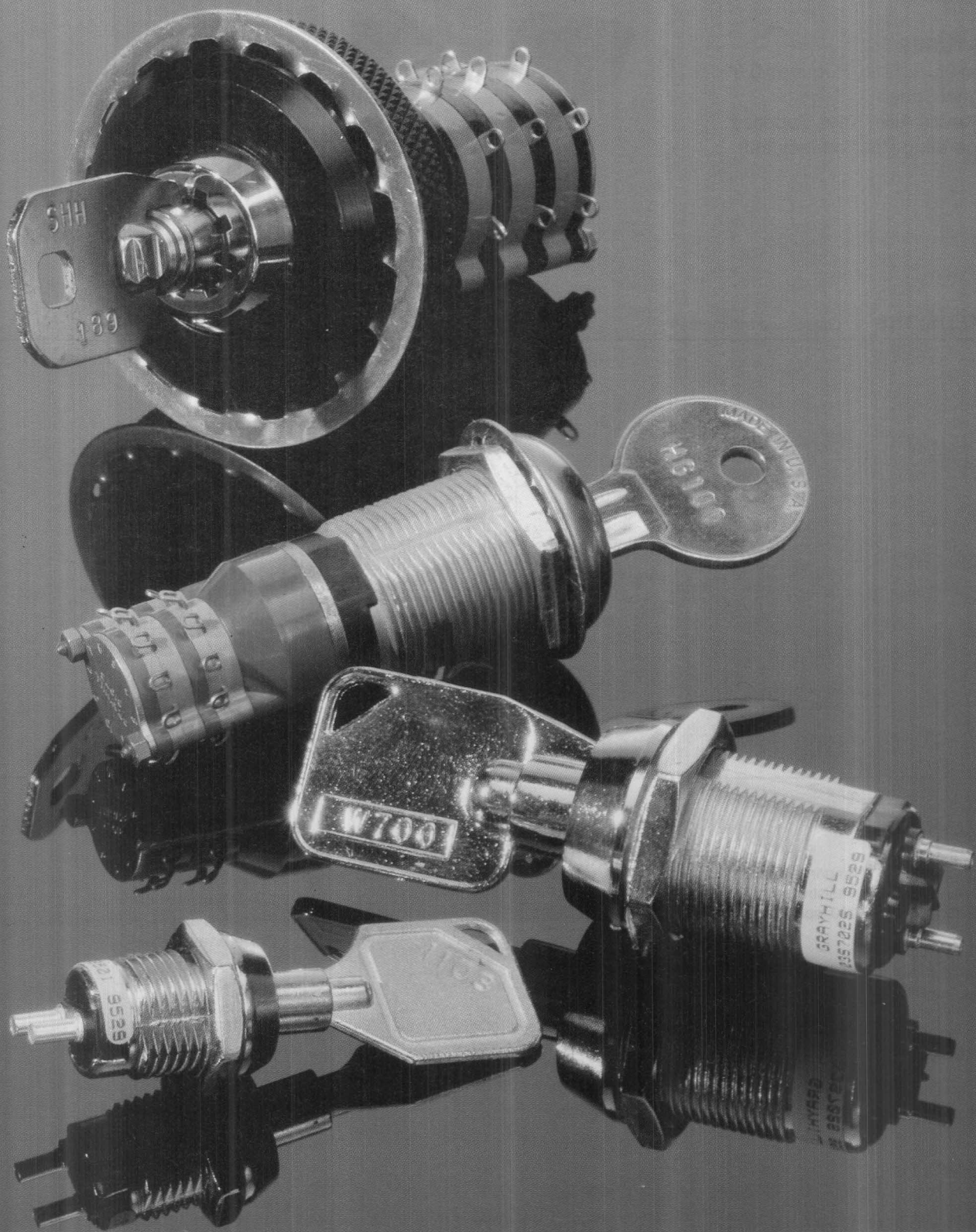
Miniature, On/Off	Series 03	F-65
DPDT	Series 03	F-66
Progressive Contact	Series 03	F-67
Multi-Level Security	Series 03	F-68
Position, Center Pull	Series 03	F-69
On/Off, Select Key Pull	Series 03	F-70

ECONOMICAL KEYLOCK SWITCHES

Single Deck, Anti-Static Lock	Series 58	F-71
Multi Deck, Standard & Anti-Static	Series 71	F-75

HIGH CURRENT KEYLOCK SWITCH

5 Amp Keylock	Series 44	F-77
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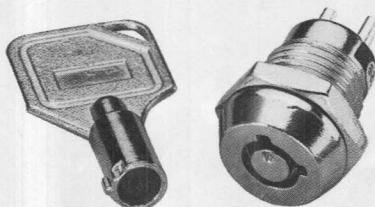
LOW-COST SECURITY KEYLOCK SWITCHES

SERIES 03

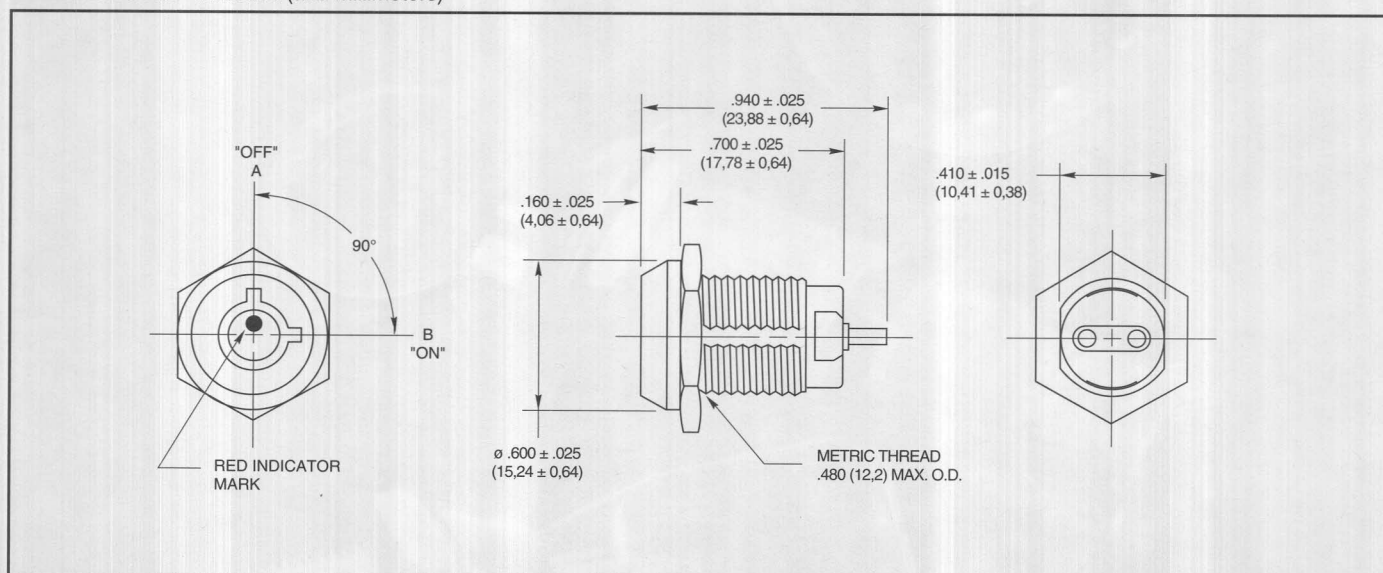
MINIATURE ON/OFF KEYLOCK SWITCH

FEATURES

- Miniature Size, Requires 0.6" Panel Space
- 2 Keyed Alike Keys Supplied
- Operating Position Indicator



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 2 Amperes @ 120 Vac or 1 Ampere @ 240 Vac, resistive load

Electrical Life: 20,000 operations or 10,000 cycles

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially
Insulation Resistance: 500 Megohms min. @ 500 Vdc

Voltage Breakdown: 1000 Vac RMS between mutually insulated parts.

Materials and Finishes

Body of Switch, Bezel, Core: Zinc, chrome plated

Contact System: Brass, silver plated

Terminals: Turret type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Gold contact plating

ORDERING INFORMATION

Part Number: 03S501

Available from your local Grayhill Distributor

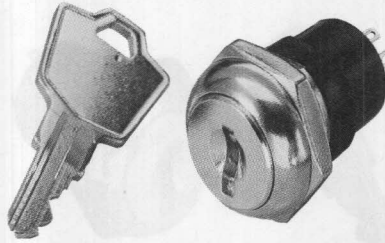
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 03

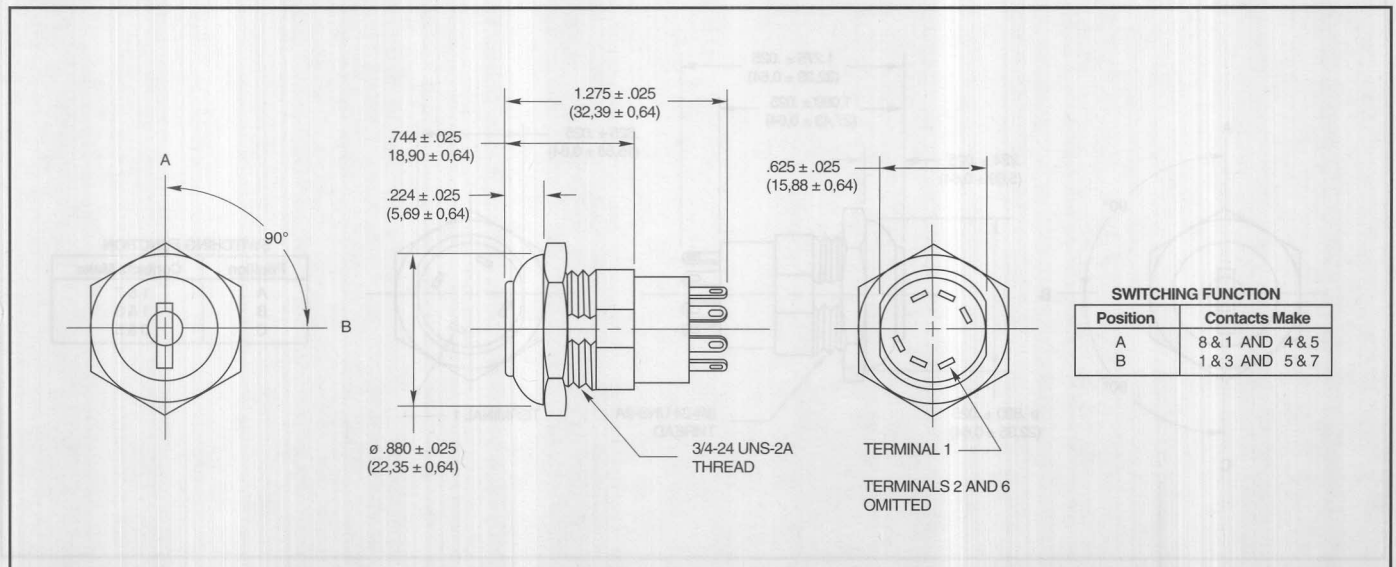
DPDT KEYLOCK SWITCH

FEATURES

- Two Positions, DPDT Function
- 2 Keyed Alike Keys Supplied
- Key Pulls in Each Position
- Drop-In Replacement for Industry Standard



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 4 Amperes @ 120 Vac or 2 Amperes @ 240 Vac, resistive load

Electrical Life: 20,000 operations or 10,000 cycles

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially

Insulation Resistance: 1000 Megohms min.

@ 500 Vdc

Voltage Breakdown: 1000 Vac RMS between mutually insulated parts.

Materials and Finishes

Switch Housing: Glass filled polyester

Lock and Bezel: Zinc alloy, nickel plated

Mounting Nut: Brass or steel, nickel or bright zinc plated

Contact System: Brass, silver plated

Terminals: Solder lug type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Stiffer or lighter switch "feel"
- Gold contact plating

ORDER INFORMATION

Part Number: 03S603

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

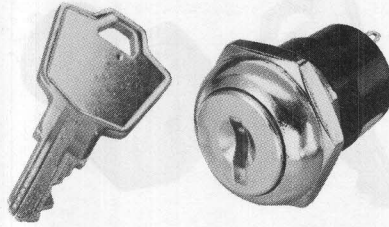
LOW-COST SECURITY KEYLOCK SWITCHES

SERIES 03

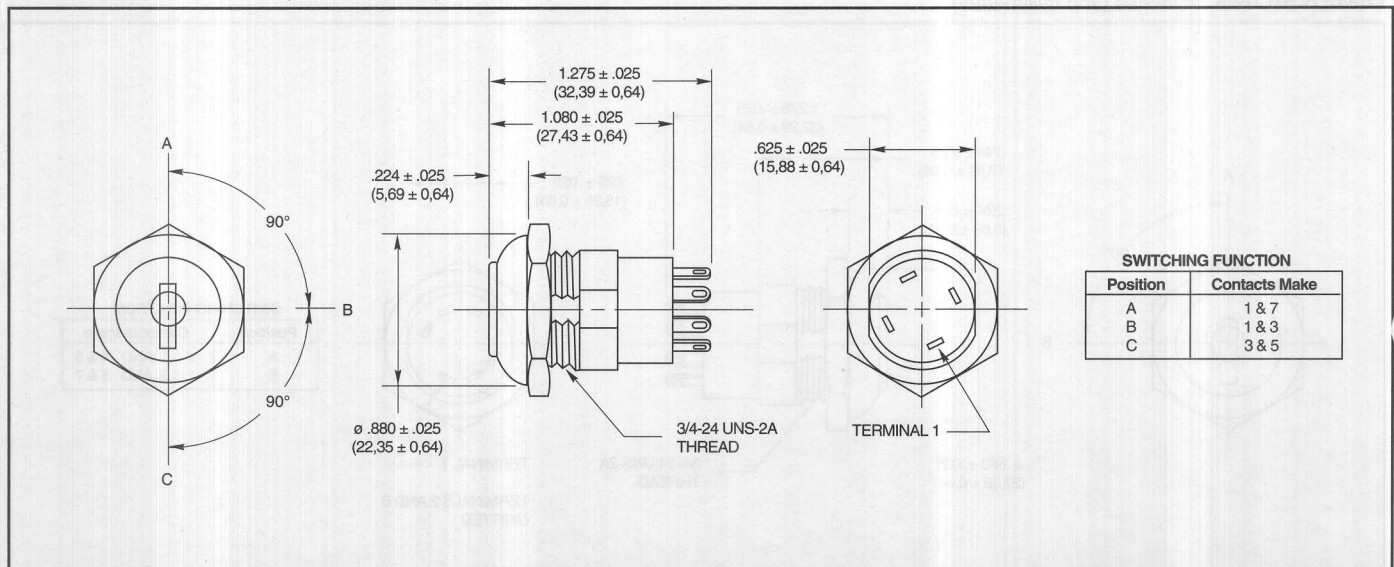
PROGRESSIVE CONTACT KEYLOCK SWITCH

FEATURES

- Three Positions, Progressive Contact
- 2 Keyed Alike Keys Supplied
- Key Pulls in Each Position
- Drop-In Replacement for Industry Standard



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 4 Amperes @ 120 Vac or 2 Ampere @ 240 Vac, resistive load

Electrical Life: 10,000 cycles of operation

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially

Insulation Resistance: 1000 Megohms min.

@ 500 Vdc

Voltage Breakdown: 1000 Vac RMS between mutually insulated parts

Materials and Finishes

Switch Housing: Glass filled polyester

Lock and Bezel: Zinc alloy, nickel plated

Mounting Nut: Brass or steel, nickel or bright zinc plated

Contact System: Brass, silver plated

Terminals: Solder lug type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Stiffer or lighter switch "feel"
- Gold contact plating

ORDERING INFORMATION

Part Number: 03S604

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 03

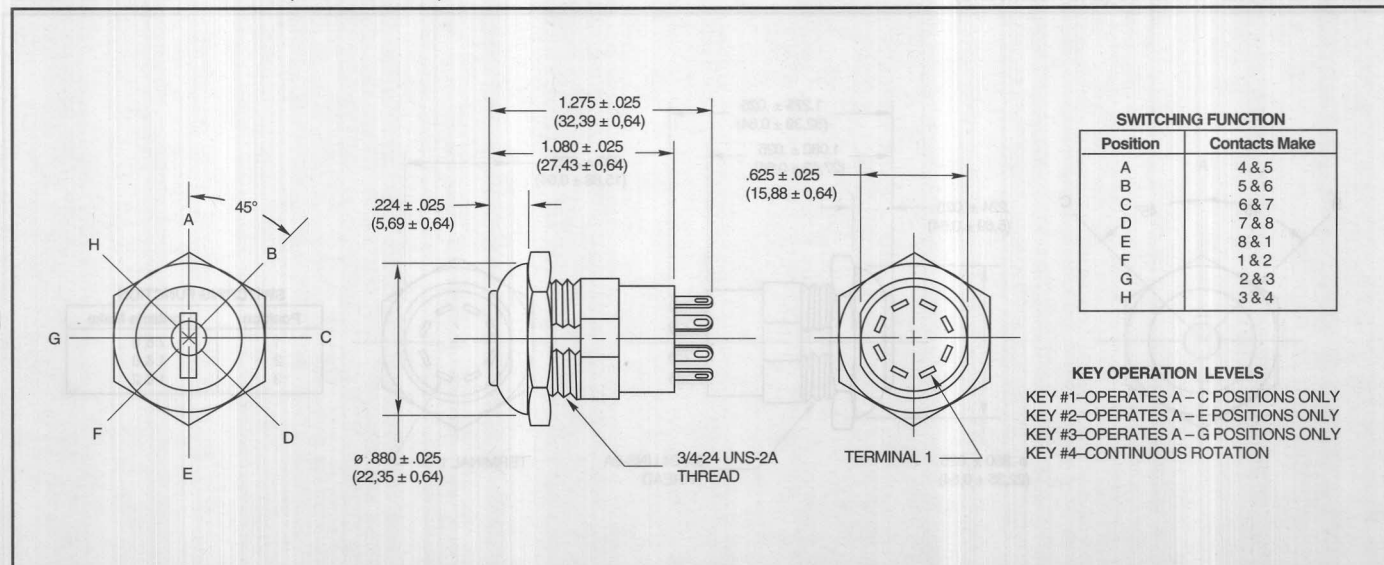
MULTI-LEVEL SECURITY KEYLOCK SWITCH

FEATURES

- Four Operator Security, Limits Access to Switch Positions
- 4 Keys Supplied; 1 for Each Security Level
- Key Pulls in Position A Only
- Drop-In Replacement for Industry Standard



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 4 Amperes @ 120 Vac or 2 Ampere @ 240 Vac, resistive load

Electrical Life: 10,000 cycles of operation

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially
 Insulation Resistance: 1000 Megohms min.
 @ 500 Vdc
 Voltage Breakdown: 1000 Vac RMS between mutually insulated parts

Materials and Finishes

Switch Housing: Glass filled polyester

Lock and Bezel: Zinc alloy, nickel plated

Mounting Nut: Brass or steel, nickel or bright zinc plated

Contact System: Brass, silver plated

Terminals: Solder lug type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Stiffer (or lighter) switch "feel"
- Gold contact plating

ORDERING INFORMATION

Part Number: 03S605

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

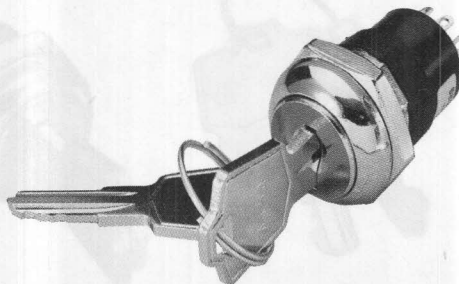
LOW-COST SECURITY KEYLOCK SWITCHES

SERIES 03

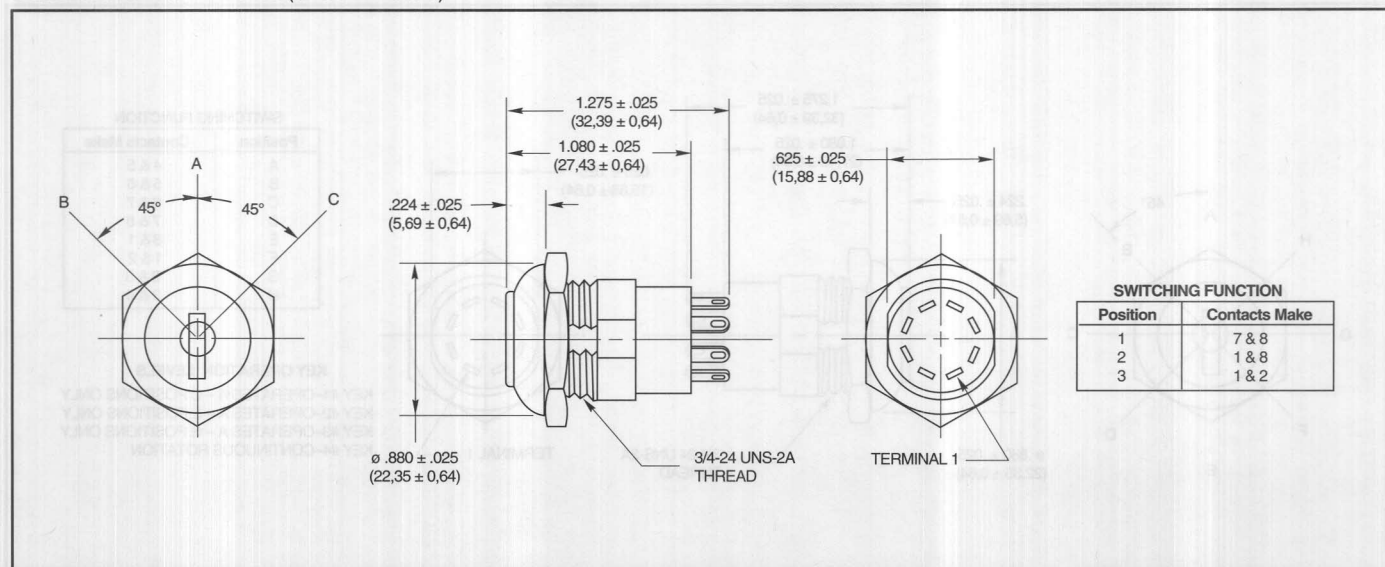
POSITION, CENTER PULL KEYLOCK SWITCH

FEATURES

- Three Positions, Progressive Contact
- 2 Keyed Alike Keys Supplied
- Key Pulls in Center Position
- Drop-In Replacement for Industry Standard



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 4 Amperes @ 120 Vac or 2 Ampere @ 240 Vac, resistive load

Electrical Life: 10,000 cycles of operation

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially

Insulation Resistance: 1000 Megohms min.

@ 500 Vdc

Voltage Breakdown: 1000 Vac RMS between mutually insulated parts

Materials and Finishes

Switch Housing: Glass filled polyester

Lock and Bezel: Zinc alloy, nickel plated

Mounting Nut: Brass or steel, nickel or bright zinc plated

Contact System: Brass, silver plated

Terminals: Solder lug type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Different Key Pulls
- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Stiffer or lighter switch "feel"
- Gold contact plating

ORDERING INFORMATION

Part Number: 03S606

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

LOW-COST SECURITY KEYLOCK SWITCHES

SERIES 03

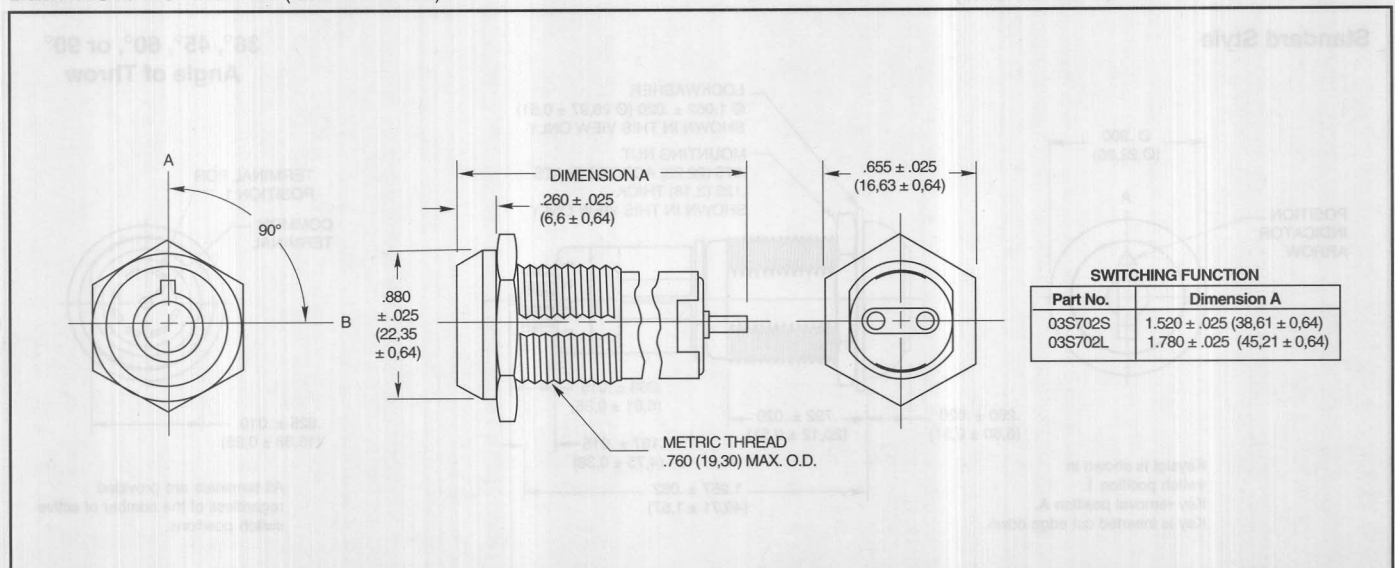
ON/OFF, SELECT KEY PULL, KEYLOCK SWITCH

FEATURES

- Choose Key Pull Location
- 2 Keyed Alike Keys Supplied



DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Rating Criteria

Contact Rating: 4 Amperes @ 120 Vac or 2 Ampere @ 240 Vac, resistive load

Electrical Life: 20,000 operations or 10,000 cycles

Life Limiting Criteria:

Contact Resistance: ≤ 10 Milliohms initially
Insulation Resistance: 500 Megohms min. @ 500 Vdc

Voltage Breakdown: 1500 Vac RMS between mutually insulated parts

Materials and Finishes

Body of Switch, Bezel, Core: Brass or zinc die cast

Contact System: Brass, silver plated

Terminals: Turret type, brass, silver plated

Keys: Brass, nickel plated

OPTIONS

- Additional Keys
- Matched Key Codes
- Key Marking; Custom Key ID
- Black Chrome Finish
- Gold contact plating

ORDERING INFORMATION

Part Number	Description
03S702S	Key pull at A and B
03S702L	Key pull at A only

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

ECONOMY KEYLOCK SWITCH

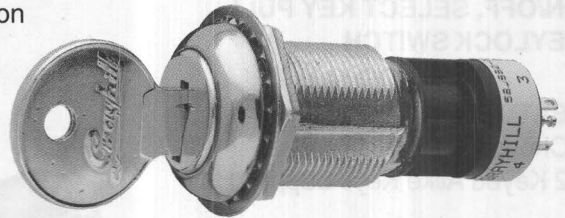
SERIES 58

LOCK FEATURES

- Minimum Space Behind Panel
- 15,000 Vdc Static Protection
- 5 Tumbler-Plate Security
- In-Panel Key Recoding

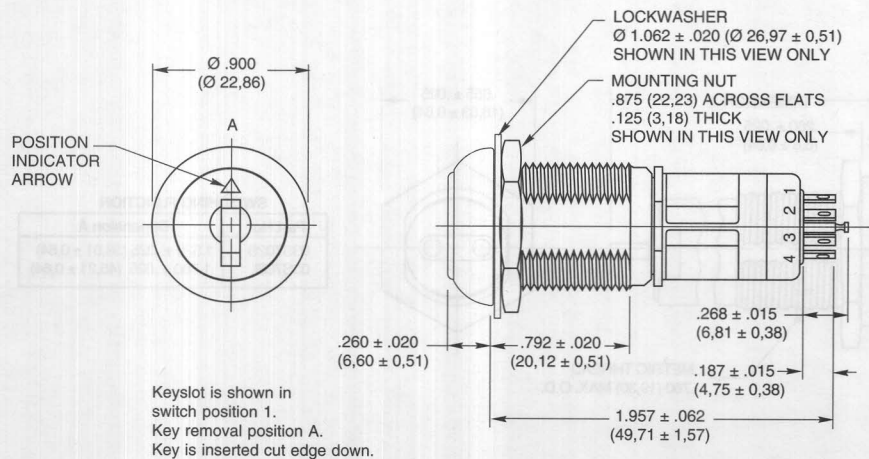
SWITCH FEATURES

- Economical
- Solder Lug or PC Mount
- 36°, 45°, 60°, or 90° Throws
- 1 or 2 Poles Per Switch
- Up to 10 Positions For 1 Pole
- 200 mA for 25,000 Cycles

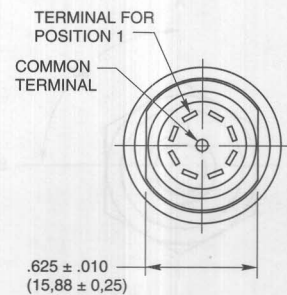


DIMENSIONS In inches (and millimeters)

Standard Style



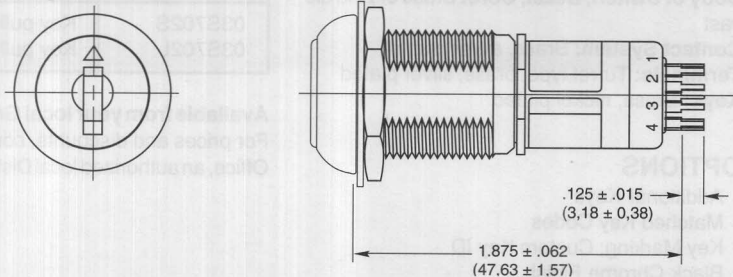
36°, 45°, 60°, or 90° Angle of Throw



All terminals are provided regardless of the number of active switch positions.

PC Mount Style

Dimensions not shown are the same as above.

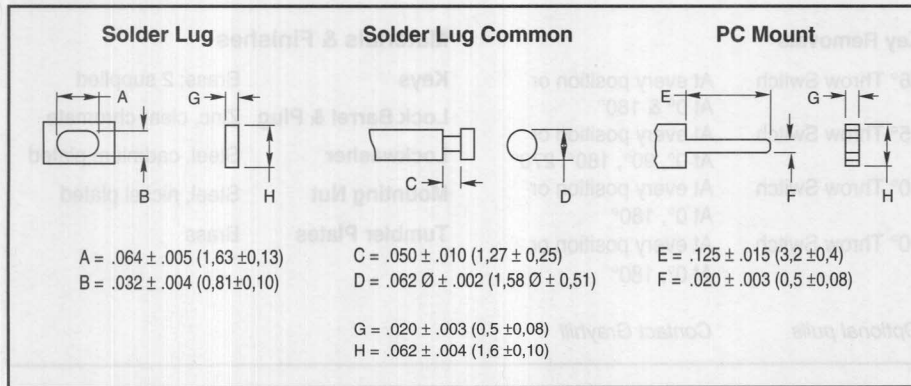


36°, 45°, 60°, or 90° Angle of Throw

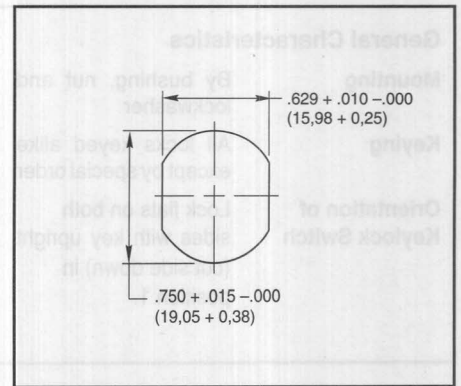


Grayhill part number and date code marked on label. Customer part number marked on request.

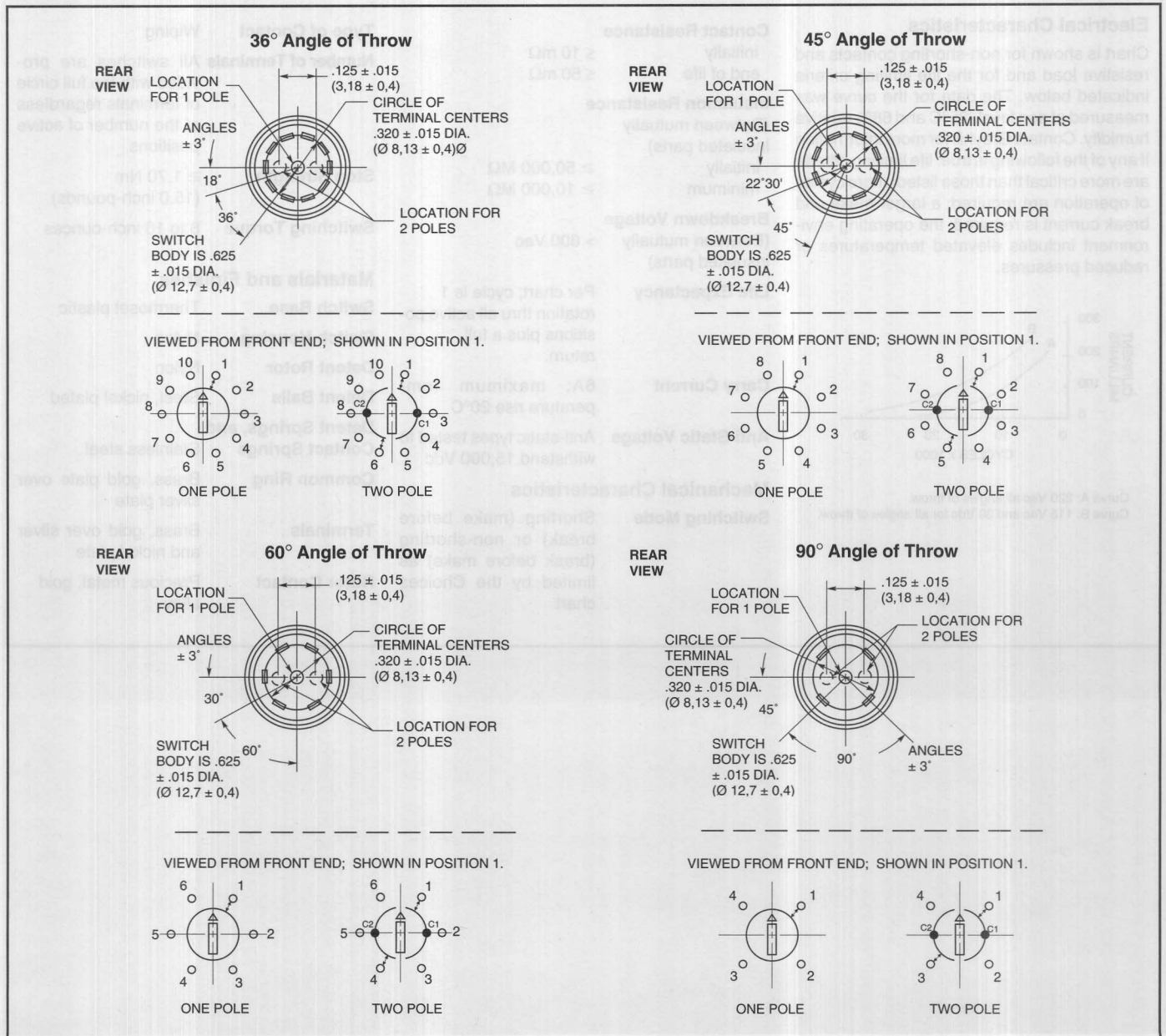
TERMINAL DETAIL



RECOMMENDED PANEL CUT



CIRCUITRY



ECONOMY KEYLOCK SWITCH

LOCK SPECIFICATIONS

General Characteristics

Mounting	By bushing, nut and lockwasher
Keying	All locks keyed alike except by special order
Orientation of Keylock Switch	Lock flats on both sides with key upright (cut side down) in position 1.

Key Removals

36° Throw Switch	At every position or At 0° & 180°
45° Throw Switch	At every position or At 0°, 90°, 180°, 270°
60° Throw Switch	At every position or At 0°, 180°
90° Throw Switch	At every position or At 0°, 180°
<i>Optional pulls</i>	<i>Contact Grayhill</i>

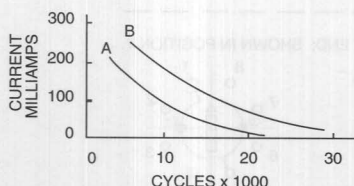
Materials & Finishes

Keys	Brass; 2 supplied
Lock Barrel & Plug	Zinc, clear chromate
Lockwasher	Steel, cadmium plated
Mounting Nut	Steel, nickel plated
Tumbler Plates	Brass

SWITCH SPECIFICATIONS

Electrical Characteristics

Chart is shown for non-shorting contacts and resistive load and for the life limiting criteria indicated below. The data for the curve was measured at sea level, 25°C and 68% relative humidity. Contact Grayhill for more information if any of the following is true: life limiting criteria are more critical than those listed; more cycles of operation are required; a larger make and break current is required; the operating environment includes elevated temperatures or reduced pressures.



Curve A: 220 Vac all angles of throw.
Curve B: 115 Vac and 30 Vdc for all angles of throw.

Contact Resistance

initially	≤ 10 mΩ
end of life	≤ 50 mΩ

Insulation Resistance

(Between mutually insulated parts)	
initially	≥ 50,000 MΩ
minimum	≥ 10,000 MΩ

Breakdown Voltage

(Between mutually insulated parts)	> 600 Vac
------------------------------------	-----------

Life Expectancy

Per chart; cycle is 1 rotation thru all active positions plus a full return.

Carry Current

6A; maximum temperature rise 20°C

Anti-Static Voltage

Anti-static types tested to withstand 15,000 Vdc

Mechanical Characteristics

Switching Mode

Shorting (make before break) or non-shorting (break before make) as limited by the Choices chart

Type of Contact

Wiping

Number of Terminals

All switches are provided with the full circle of terminals regardless of the number of active positions

Stop Strength

≥ 1.70 Nm
(15.0 inch-pounds)

Switching Torque

8 to 16 inch-ounces

Materials and Finishes

Switch Base	Thermoset plastic
Switch Housing	Nylon
Detent Rotor	Nylon
Detent Balls	Steel, nickel plated
Detent Springs, and Contact Springs	Stainless steel
Common Ring	Brass, gold plate over silver plate
Terminals	Brass, gold over silver and nickel plate
Rotor Contact	Precious metal, gold alloy

CHOICES AND LIMITATIONS

Lock Style and Description*	Switch Style and Description	Angle of Throw	No. Of Decks	Poles/Deck	Positions Per Pole**	Shorting or Non-Shrtg.
Series 58J Switches						
J4: Standard—Key pulls at Position 1 and at 90 Degree Increments	A = Standard, Solder Lugs P = Standard PC Mount	45°	1	1 2	02 to 8 02 to 04	N or S N or S
J8: Standard—Key Pulls at Each Position	A = Standard, Solder Lugs P = Standard, PC Mount	36°	1	1 2	02 to 10 02 to 05	N or S N or S
		45°	1	1 2	02 to 08 02 to 04	N or S N or S
		90°	1	1 2	02 to 04 02	N N
		36°	1	1 2	02 to 10 02 to 05	N or S N or S
J9: Standard—Key Pulls at Position 1 and at 180 Degrees	A = Standard, Solder Lugs P = Standard, PC Mount	45°	1	1 2	02 to 08 02 to 04	N or S N or S
		60°	1	1 2	02 to 06 02 to 03	N N
		90°	1	1 2	02 to 04 02	N N

*Standard Keylock has anti-static protection. All keylock versions available without anti-static protection, with a reduced overall body length. Contact Grayhill for more information.

**For single pole switches with maximum positions, specify continuous rotation or fixed stop when ordering.

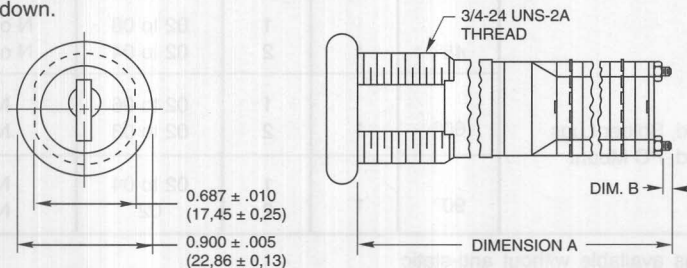
ORDERING INFORMATION

	Series
	Lock Style: per Choices Chart J4, J8, J9
	Switch Style: per Choices Chart A or P
	Angle of Throw: 36, 45, 60 or 90 (per Choices chart)
	Number of Decks: 01
	Poles per Deck: = 1 or 2 (per Choices chart)
	Positions per Pole: 02 thru 10 (per Choices chart)
	Type of Contacts: (per Choices chart)
	N = Non-shorting S = Shorting (per Choices chart)
	Stop Arrangement Suffix:
	(needed only for 1-pole switches with maximum positions)
	F = Fixed stop between last and first positions C = Continuous rotation
58J8A36-01-1-10N-F	

Available from your local Grayhill Distributor. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

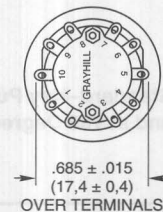
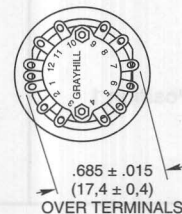
DIMENSIONS In inches (and millimeters)

Key slot shown in position 1.
Key to be inserted with cut
side down.



30°

36°



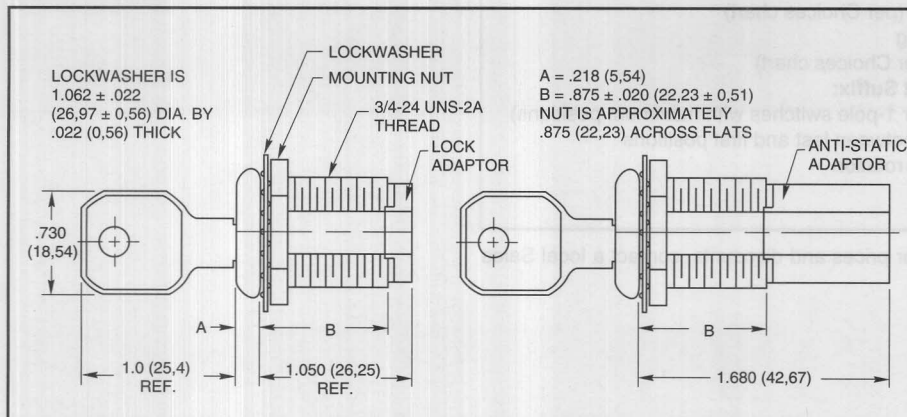
Note: Switch/key positions are not aligned with terminal positions.

Number of decks	1	2	3	4	5	6	7	8	9	10	11	12
Dim. A, Style J (in.)	2.441	2.659	2.877	3.095	3.313	3.811	4.029	4.247	4.465	4.683	4.901	5.119
Dim. A, Style L (in.)	1.811	2.029	2.247	2.465	2.683	3.181	3.399	3.617	3.835	4.053	4.271	4.489
Dim. B Style J & L (in.)	.031	.031	.031	.031	.031	.312	.312	.312	.312	.312	.312	.312
Dim. A, Style J (mm)	62,00	67,54	73,08	78,61	84,15	96,80	102,34	107,87	113,41	118,95	124,49	130,02
Dim. A, Style L (mm)	46,00	51,54	57,07	62,61	68,15	80,80	86,33	91,87	97,41	102,95	108,48	114,02
Dim. B Style J & L (mm)	0,79	0,79	0,79	0,79	0,79	7,92	7,92	7,92	7,92	7,92	7,92	7,92

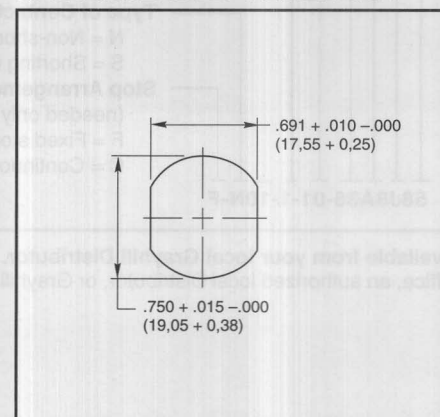
For switch specifications and additional dimensions, see Standard Switch Pages.

Grayhill part number and date code marked on label.
Customer part number marked on request.

LOCK DETAIL



RECOMMENDED PANEL CUT



ECONOMICAL KEYLOCK SWITCH

CHOICES

Style	Description	Angle of Throw	No. Of Decks	Poles/Deck	Positions Per Pole	Shorting or Non-Shrtg.
Series 71 Switches						
L J	Standard, Solder Lugs Anti-static, Solder Lugs	30°	01 to 12	1	02 to 12*	N or S
			01 to 08	2	02 to 06	N or S
			01 to 05	3	02 to 03	N or S
			01 to 04	4	02 to 03	N or S
			01 to 03	5	02	N or S
			01 or 02	6	02	N or S
		36°	01 to 12	1	02 to 10*	N or S
			01 to 08	2	02 to 05	N or S

*For single pole switches with maximum positions, specify continuous rotation or fixed stop when ordering.

LOCK SPECIFICATIONS

Mounting: By bushing, nut and lockwasher
Static Voltages: Anti-static style withstands 15,000 Vdc
Keying: All locks have identical keys unless specially ordered otherwise

Key Removal

30° throw Position 1 and 180°
 Special key removal Every 90°
 36° throw All positions
 Special key removal Position 1 only

Orientation of Keylock Switch: Bushing flats are on both sides of the mounting thread with the key upright in the first position with cut side down.

LOCK MATERIALS & FINISHES

Keys: Brass; 2 supplied
Lock Bezel: Stainless steel
Lock Barrel & Plug: Zinc treated with chromate
Lock Adaptor/Extension: Thermoplastic

ORDERING INFORMATION

Series	71
Style Letter: L for standard; J for anti-static	L
Angle of Throw: 30 or 36	30
Number of Decks: 01 thru 12 (per Choices chart)	03
Poles per Deck: 1 thru 6 (per Choices chart)	1
Positions per Pole: 02 thru 12 (per Choices chart)	12
Type of Contacts:	N-F
N = Non-shorting	
S = Shorting	
Stop Arrangement Suffix:	
(needed only for 1-pole switches with maximum positions)	
F = Fixed stop between last and first positions	
C = Continuous rotation	

STANDARD SWITCH PAGES

For additional switch dimensions, ratings, circuitry, and specifications, see Series 71 switches, beginning on page F-29.

Available from your local Grayhill Distributor
 For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

HIGH CURRENT KEYLOCK SWITCH

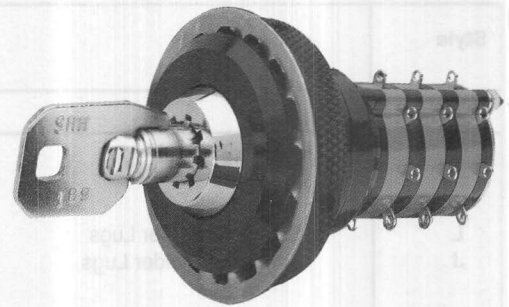
SERIES 44L

LOCK FEATURES

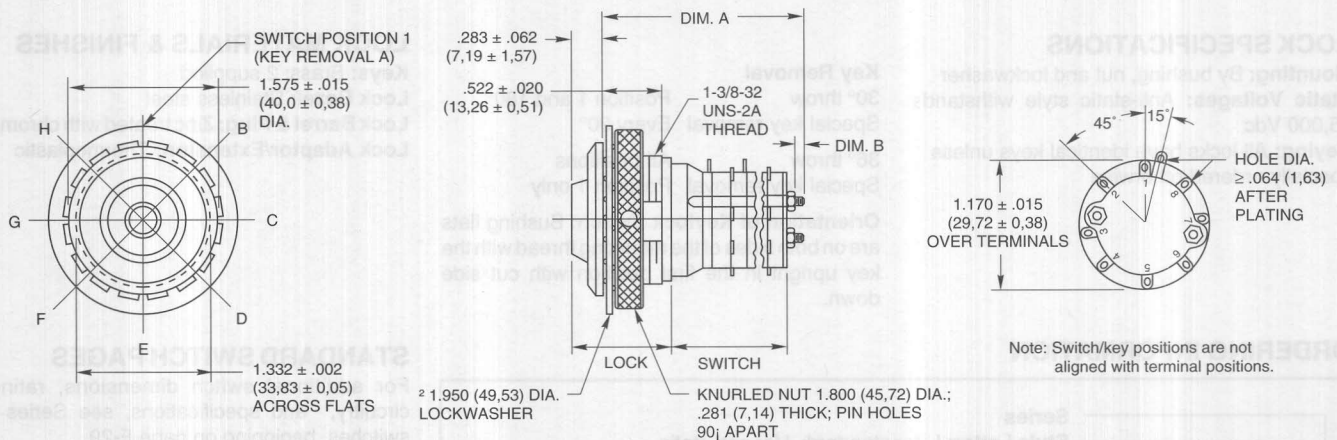
- 8-Pin, Round Key Security
- Options for Flat Keys, Special Keying, and Key Removals

SWITCH FEATURES

- High, 5-Amp Current Switching
- 45°, Up to 8 Poles Per Switch
- 25,000 Cycles of Operation
- Options for Military Qualified Switch & More Switching Decks



DIMENSIONS In inches (and millimeters)

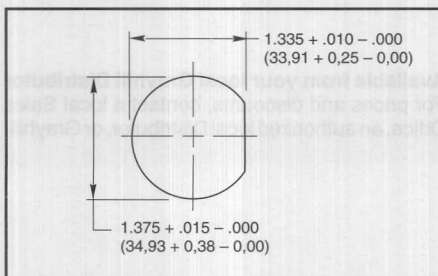


No. of decks	1	2	3	4	5	6
Dim. A (In.)	1.556	1.902	2.248	2.594	2.940	3.536
Dim. B (In.)	.062	.062	.062	.062	.062	.312
Dim. A (mm)	39,52	48,31	57,10	65,89	74,68	89,81
Dim. B (mm)	1,57	1,57	1,57	1,57	1,57	7,92

No. of Decks	1	2	3	4	5	6
Approx. Weight in Grams	123	120	127	144	151	158

Grayhill part number and date code marked on label.
Customer part number marked on request.

RECOMMENDED PANEL CUT



LOCK SPECIFICATIONS

Keying: Each lock is keyed differently
Key Removal: All positions (45°, etc)
Special Options: Flat key with 90° or 180° increment key removals; 7 thru 12 decks; and Military qualified switches.

LOCK MATERIALS AND FINISHES

Bushing and Knurled Spanner Nut: Aluminum, black anodized
Keying Washer, Cover Support Plate, Shaft Extension: 302 Stainless steel
Internal and External Lockwashers: Steel, cadmium plated
Keys, Cylindrical: Stainless steel; 2 supplied

CHOICES AND LIMITATIONS

Style	Description	Angle of Throw	No. Of Decks	Poles/ Deck	Positions Per Pole	Shorting or Non-Shrtg.
Series 44 Switches						
L	Standard, Solder Lugs	45°	01 to 06 01 to 03 01 or 02 01 or 02	1 2 3 4	02 to 08 02 to 04 01 or 02 01 or 02	N or S N or S N N

SWITCH SPECIFICATIONS

Electrical Characteristics		Mechanical Characteristics		Materials and Finishes - Switch	
Industrial Grade Switch		Switching Mode		Switch Bases	Melamine per MIL-M-14, 4
Switching Current and Life		45°, 1 or 2 poles		Switch Bases	
The load-life values indicate the number of cycles of operation expected for the voltage, current and type of load. End of life is defined using the resistance and breakdown failure criteria listed below.		Shorting or non-shorting		Industrial Grade	
5 A at 115 Vac, resistive		45°, 3 or 4 poles		Military	
1 A at 6 to 28 Vdc, resistive		Type of Contact		Cover, Deck Separators, End Plate, and Rotor Mounting Plate	
2 A at 115 Vac, inductive		Wiping contacts		Phenolic per MIL-M-14	
Cycle of Operation		Contact Force		Shaft, Shaft Extension, Stop Arm, Stop Washers, Rear Support Plate, Cover Plate, Retaining Ring, Studs, Nuts	
360° rotation plus a 360° return		>150g		Stainless steel, passivated	
Test Conditions		Number of Terminals		Detent Balls	
25°C, 68% relative humidity, atmospheric pressure		Switches are provided with only the number of terminals needed		Steel, nickel plated	
Life Expectancy		Stop Strength		Detent Springs	
with loads above 25,000 cycles		>15 pound-inches (1.70 Nm)		Tinned music wire	
without load 100,000cycles		Switching Torque		Rotor Contact, and Stator (Base) Contacts	
Contact Resistance		8-115 ounce-inches (28 to 230 mNm), depending on the number of poles, number of decks, and angle of throw		Silver alloy	
end of life ≤ 20 mΩ		Additional Characteristics		Common Plate, and Common Terminal	
Insulation Resistance		Switches of 6 or more decks have longer studs with extra mounting nuts for recommended double end mount		Brass, ⊕ 300 μinch (7.6 μm) silver plate	
(Between mutually insulated parts)				Base Terminals	
initially ≥ 50,000 MΩ				Brass, lead-tin plated and fused	
Breakdown Voltage					
(Between mutually insulated parts)					
initially: ≥ 1,000 Vac					
end of life: ≥ 500 Vac					
Carry Current					
10 A; maximum temperature rise 20°C					

ORDERING INFORMATION

	Series
	Style Letter: L
	Angle of Throw: 45°
	Number of Decks: 01 thru 06 (per Choices chart)
	Poles per Deck: 1 thru 4 (per Choices chart)
	Positions per Pole: 02 thru 08 (per Choices chart)
	Type of Contacts:
	N = Non-shorting
	S = Shorting (per Choices chart)
	Stop Arrangement Suffix: (needed only for 1-pole switches with maximum positions)
	F = Fixed stop between positions 8 and 1
	C = Continuous rotation
44 L 45-02-1-08 N-F	

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SPECIAL FUNCTION ROTARY SWITCHES

- Spring Return Switches With Choices of Maintained and Momentary Positions
- Pull-To-Turn and Push-To-Turn Switches With Choices of Isolated Positions

SELECTION E-7

SPRING RETURN ROTARY SWITCHES

Momentary Position Switches Series 8/9, 42/44, 50 F-81

ISOLATED POSITION ROTARY SWITCHES

Pull-To-Turn Series 9, 42/44, 50/51 F-83

Push-To-Turn Series 9, 42/44, 50/51 F-83



SPRING RETURN ROTARY SWITCHES

FEATURES

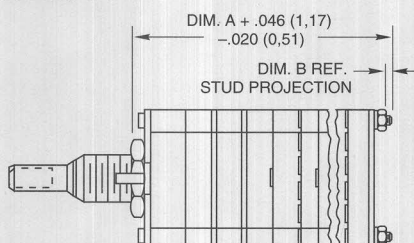
- Hold-To-Test, Hold-To-Calibrate, And Other Momentary Applications
- Choice of Configurations, Ratings, Styles and Circuitry

DESCRIPTION

A spring return rotary switch has 1 or more momentary positions. Maintaining contact at momentary positions requires rotational force. Releasing the force allows the mechanism to return the contact to a normal, or detent, position.

DIMENSIONS

Series 8 & 9

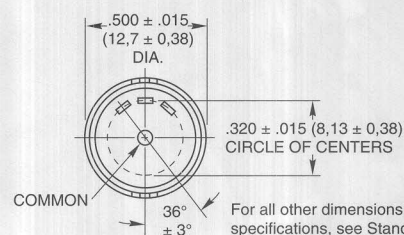
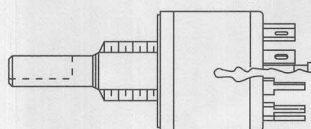


No. of Decks	Dim A	Dim B
1	.960 (24,38)	.062 (1,57)
2	1.228 (31,19)	.062 (1,57)
3	1.496 (38,0)	.062 (1,57)
4	1.764 (44,81)	.062 (1,57)
5	2.032 (51,61)	.062 (1,57)
6	2.550 (64,77)	.312 (7,92)

For all other dimensions and specifications, see Standard Switch pages.

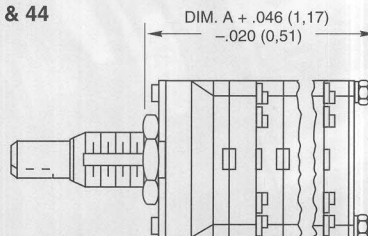
Series 50

Equivalent to Series 50 Standard Switches



For all other dimensions and specifications, see Standard Switch pages.

Series 42 & 44



No. of Decks	Dim. A
1	1.025 (26,04)
2	1.371 (34,82)
3	1.717 (43,61)

For all other dimensions and specifications, see Standard Switch pages.

STANDARD SWITCH PAGES

Series 8 & 9	Pages F-43 to F-48
Series 42 & 44	Pages F-49 to F-58
Series 50	Pages F-15 to F-19

CONFIGURATIONS

This configuration indicates a counter-clockwise force is required to hold the switch at position #1. "M" indicates a momentary position counter-clockwise of "D" and "D", detented ones.

Positions	1	2	3
	M	D	D

Releasing this force breaks contact with position #1 and returns the switch to #2. Normal rotary switch detent action occurs when the switch is rotated between position #2 and #3.

All of the configurations (except *MDM*) list a basic 2 position arrangement which is shown in italics. Example: *MDDDDD* or *DDDDDM*. Several positions can be added during the switch construction at the factory; but, any configuration must always contain the 2 basic positions.

SELECTING A SWITCH

1. Select a Configuration: The total number of positions always includes the 2 basic positions. A 4 position switch of *DDDDM* configuration would have 3 detent positions counter-clockwise of the momentary position.

2. Select Series, Angle of Throw, and Style: See the Choices Chart. The basic switch description, series, and throw are as follows:
 1/2", 1/4 Amp, multi deck 8 = 36° 9 = 30°
 1", 1 Amp, multi deck 42 = 36° 44 = 30°
 1/2", 200 mA, single deck 50 = 36°

Electrical ratings are the same as those of the conventional switches with the exception of life. Life is limited to 10,000 cycles of operation (25,000 cycles for Series 50) due to the spring arrangement. Dimensions are the same as for conventional types except for the shaft flat orientation of the 3, 4, 5, and 6 pole, Series 9 and 44 in the *DDDDM* configuration (see chart).

3. Select Poles & Positions Per Pole: If you do not find the poles and positions per pole you need in one series, try another or contact the factory. If the behind panel length is a problem, select a multi-pole type instead of a single deck.

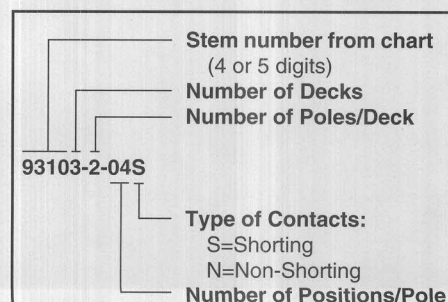
OPTIONS

Watertight panel seal; Multi-pole switches that exceed the limits noted in the Selector Chart; Series 50 *MD* or *DM* configurations in Military styles; Series 8, 9, & 44 in *MMDDMM*, and in *MMDDMM*, and in *MMMMMD*.

Not available through Distributors

ORDERING INFORMATION

Create the part number using this example.



Exception: Numbers beginning with 5 are already complete part numbers.

SPRING RETURN ROTARY SWITCHES

CHOICES AND LIMITATIONS

Con-figuration	Conven-tional Switch	Description Of Style	Spring Return Stem Number (See Ordering Info.)	No. Of Decks	Poles Per Deck	Positions Per Pole & Contact Type	Location Of Unique Position, Detent or Momentary	Term. Opp. Flat**
DDDDDM	8A36	Standard	8317	1 to 6 1 to 3	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 5 M 5, 10	5 5
	9A30	Standard	9310	1 to 6 1 to 3 1 or 2 1 1	1 2 3 4 5 or 6	02 to 06 (N or S) 02 to 06 (N or S) 02 to 04 (N or S) 02 or 03 (N or S) 02 (N or S)	M 6 M 6, 12 M 4, 8, 12 M 3, 6, 9, 12 M 2, 4, 6, 8, 10, 12	6 6 4 3 2
	42A36	Standard	42349	1 to 3 1	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 5 M 5, 10	5 5
	42M36	Military	42352	1 to 3 1	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 5 M 5, 10	5 5
	44A30	Standard	44346	1 to 3 1	1 2	02 to 06 (N or S) 02 to 06 (N or S)	M 6 M 6, 12	6 6
	44M30	Military	44350	1 to 3 1	1 2	02 to 06 (N or S) 02 to 06 (N or S)	M 6 M 6, 12	6 6
MDDDDD	8A36	Standard	8319	1 to 6 1 to 3	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 1 M 1, 6	1 1
	9A30	Standard	9312	1 to 6 1 to 3 1 or 2 1 1	1 2 3 4 5 or 6	02 to 06 (N or S) 02 to 06 (N or S) 02 to 04 (N or S) 02 or 03 (N or S) 02 (N or S)	M 1 M 1, 7 M 1, 5, 9 M 1, 4, 7, 10 M 1, 3, 5, 7, 9, 11	1 1 1 1 1
	9M30	Military	9356	1 to 3 1 1	1 2 3	02 to 06 (N or S) 02 to 06 (N or S) 02 to 04 (N or S)	M 1 M 1, 7 M 1, 5, 9	1 1 1
	42A36	Standard	42350	1 to 3 1	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 1 M 1, 6	1 1
	42M36	Military	42353	1 to 3 1	1 2	02 to 05 (N or S) 02 to 05 (N or S)	M 1 M 1, 6	1 1
	44A30	Standard	44312	1 to 3 1	1 2	02 to 06 (N or S) 02 to 06 (N or S)	M 1 M 1, 7	1 1
	44M30	Military	44351	1 to 3 1	1 2	02 to 06 (N or S) 02 to 06 (N or S)	M 1 M 1, 7	1 1
MDM	50A36	Std., Solder Lug	503265-1-03N*	1	1	03N	D 2	2
	50P36	Std., PC Mount	503267-1-03N*	1	1	03N	D 2	2
	8A36	Standard	8316	1 to 6 1 to 3	1 2	03 (N or S) 03 (N or S)	D 2 D 2, 7	2 2
	9A30	Standard	9311	1 to 6 1 to 3 1 or 2 1	1 2 3 4	03 (N or S) 03 (N or S) 03 (N or S) 03 (N or S)	D 2 D 2, 8 D 2, 6, 10 D 2, 5, 8, 11	2 2 2 2
	42A36	Standard	42348	1 to 3 1	1 2	03 (N or S) 03 (N or S)	D 2 D 2, 7	2 2
	42M36	Military	42351	1 to 3 1	1 2	03 (N or S) 03 (N or S)	D 2 D 2, 7	2 2
	44A30	Standard	44345	1 to 3 1	1 2	03 (N or S) 03 (N or S)	D 2 D 2, 8	2 2
	44M30	Military	44349	1 to 3 1	1 2	03 (N or S) 03 (N or S)	D 2 D 2, 8	2 2

*This is a complete (not stem) part number.

**Terminal opposite shaft flat when switch is in it unique (detent or momentary) position.

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

All switches charted above are available from your local Grayhill Distributor



ISOLATED POSITION ROTARY SWITCHES

FEATURES

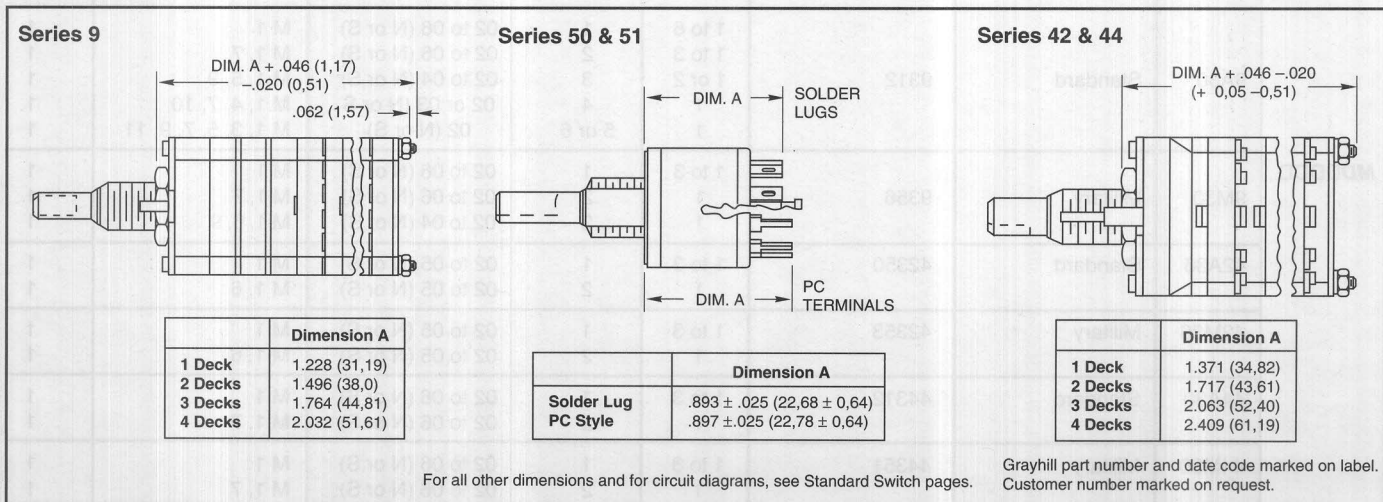
- Protected Switch Positions For Safety, Calibration, or Stand-by
- Choice of Push- or Pull-To-Turn
- 1/2" Diameter, 200 mA and 1" Diameter, 1 Amp Switches
- 10,000 Cycles of Operation

DESCRIPTION

An isolated position is one which cannot be reached by the normal rotation. An additional action is required by the operator. It could be either Push-To-Turn, or Pull-To-Turn. After the switch is rotated to the isolated position, releasing the shaft locks the switch in that position. Push or pull again to rotate the switch again.

Use isolated positions to protect a switch position from indiscriminate rotation. Such safety positions might include "calibrate", "off" and/or "stand-by".

DIMENSIONS



EXTERNAL DIFFERENCES

The isolated position mechanism increases the depth of the Series 50 and 51 by 0.217" (5,51 mm). All other dimensions remain unchanged. In Series 9, 42 and 44, it has the appearance of an additional deck section without terminals, located directly behind the detent system.

SHAFT AND PANEL SEALS

For detailed important dimensions of the bushing to panel seal, see Standard Switch Pages.

STANDARD SWITCH PAGES:

Series 9	Page F-43 thru F-48
Series 42 and 44	Page F-49 thru F-58
Series 50 and 51	Page F-15 thru F-19

SPECIFICATIONS

Electrical Ratings

The switching elements, and therefore ratings, are the same in an isolated position switch as in a conventional rotary switch. Mechanical life is also the same. See Standard Switch pages.

Additional Characteristics

Shaft Movement or Vertical Travel:

Series 9	.062 ± .020 (1,57 ± 0,51)
Series 42 & 44	.070 ± .020 (1,78 ± 0,51)
Series 50 & 51	.080 ± .020 (2,03 ± 0,51)

Push or Pull Force Required:

Series 9	1.75 ± .5 lbs
Series 42 & 44	2 ± .5 lbs
Series 50 & 51	2 ± .5 lbs

Stops: Single pole per deck switches with the maximum number of positions are supplied with stops only on request: 12 positions in 30° throw, 10 in 36°, and 8 in 45°.

Stop Strength: Approximately 7.5 pound inches for the isolated position stop. Refer to Standard Switch Specifications for remaining standard stops.

Materials and Finishes

Materials and finishes for the isolation mechanism are listed here. See Standard Switch Pages for all other materials.

Series 50 and 51

Housing: Zinc, cadmium plated per QQ-P-416
Shaft: 303 Stainless steel, passivated
Stop Pin and Stop Post: 303 stainless steel
Spring: Tinned music wire

Series 9

Housing: Phenolic for style A; Diallyl, for M
Shaft: 303 stainless steel, electro-polished
Stop Pin and Stop Post: 303 Stainless steel
Spring: Tinned music wire

Series 42 and 44

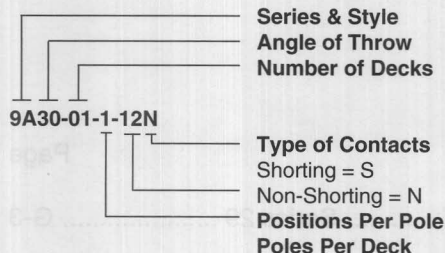
Housing: Diallyl per MIL-M-14
Shaft: 303 stainless steel, passivated
Lock Plate: 302 stainless steel, passivated
Lock Arm: 316 stainless steel, passivated
Lock Post: Brass, cadmium plated
Compression Spring: Tinned music wire

—	42HS	125° Temp Rating, Sealed					
44A	44M	Solder Lug	30°	01 to 04	1	02 to 12	N or S
44S	—	Sealed		01 to 04	2	02 to 06	N or S
—	44H	125° Temperature Rating		01 to 04	3	02 to 04	N or S
—	44HS	125° Temp Rating, Sealed		01 to 04	4	02 or 03	N or S
				01 to 04	5	02	N or S
				01 to 04	6	02	N or S
			45°	01 to 04	1	02 to 08	N or S
				01 to 03	2	02 to 04	N or S
				01 or 02	3	02	N or S
				01 or 02	4	02	N
--	50C	Solder Lug	36°	01	1	02 to 10	N or S
--	50CP	PC Mount			2	02 to 05	N or S
--	50M*	Solder Lug, Sealed					
--	50MP*	Sealed, PC					
--	51C	Solder Lug	30°	01	1	02 to 12	N or S
--	51CP	PC Mount			2	02 to 06	N or S
--	51M*	Solder Lug, Sealed			3	02 or 03	N or S
--	51MP*	PC Mount, Sealed			4	02 or 03	N or S

*(Pull-to-Turn only) **For specifics on military qualified products, see Standard Switch Pages.

CONVENTIONAL NUMBERS

Start by creating a conventional switch number in the manner which follows:



Note: No stop arrangement suffix is needed. See Describing Stops.

DESCRIBING POSITIONS

The Grayhill system for isolating positions lets you choose the positions to be isolated. Grayhill inserts isolation posts next to the positions to be isolated. Consider a continuous rotation switch of the Series 9A with a 30° angle of throw. The terminals are listed here from 1 through 12 with a space between each to indicate where isolation posts might be inserted.

12 1 2 3 4 5 6 7 8 9 10 11 12

Let's isolate position 1 and position 2 from all other positions and from each other. We indicate isolation posts as shown here:

12P1P2P3 4 5 6 7 8 9 10 11 12

To isolate just position 1, describe like this:

12P1P2 3 4 5 6 7 8 9 10 11 12

To isolate positions 1 and 2 from all other positions, but not from each other, do this:

12P1 2P3 4 5 6 7 8 9 10 11 12

DESCRIBING STOPS

When a 1-pole switch has less than the maximum number of positions, consider also the stop system. Following is the arrangement for a 6 position switch with the position 1 isolated.

STOP 1P2 3 4 5 6 STOP

The word "STOP" indicates the the conventional switch stops, which limit rotation to positions 1 through 6. To isolate position 1 we insert only one isolation post—between terminals 1 and 2. The stop system already prevents rotation beyond terminal 1.

In multi pole switches, the stop system and isolation system described for the first pole, automatically affects the other poles. In the example above, isolating position #1 on the first pole isolates the first position (terminal #7) of the second pole. See Standard Switch Pages for a 2 pole circuit diagram for a 30° throw switch.

ORDERING INFORMATION

Indicate this as a SPECIAL switch to ensure that no error is made when the order is entered. Sample part number:

SPECIAL
 9A30-04-1-12N
 PULL 12P1P2P3 4 5 6 7 8 9 10 11 12

This sample part number orders a Series 9 standard style, four deck, one pole per deck, twelve positions per pole rotary switch with non-shorting contacts and isolation posts between positions 12 and 1, between 1 and 2, and between 2 and 3.

This lengthy order number is required to prevent any possible confusion in ordering the switch. When we receive your order, we will assign a special "short form" part number to facilitate future identification of this special switch. This number is sequentially assigned as the need arises, and is non-descriptive. A typical "short form" special part number might be 9YY12345. Contact Grayhill for price.

Not available through Distributors.



CONTENTS: TERMINATION HARDWARE

Standard Style	Mount Style	Style Description	Angle Of Throw	No. Of Decks	Post Per Deck	Position Per Line	Spacing Or Non-Spacing
2A	3A	Solder Lug	30°	01 to 04	1	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	2	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	3	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	4	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	5	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	6	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	7	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	8	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	9	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	10	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	11	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	12	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	13	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	14	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	15	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	16	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	17	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	18	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	19	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	20	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	21	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	22	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	23	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	24	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	25	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	26	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	27	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	28	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	29	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	30	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	31	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	32	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	33	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	34	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	35	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	36	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	37	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	38	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	39	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	40	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	41	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	42	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	43	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	44	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	45	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	46	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	47	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	48	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	49	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	50	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	51	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	52	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	53	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	54	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	55	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	56	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	57	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	58	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	59	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	60	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	61	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	62	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	63	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	64	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	65	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	66	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	67	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	68	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	69	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	70	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	71	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	72	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	73	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	74	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	75	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	76	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	77	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	78	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	79	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	80	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	81	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	82	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	83	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	84	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	85	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	86	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	87	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	88	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	89	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	90	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	91	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	92	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	93	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	94	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	95	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	96	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	97	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	98	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	99	02 to 12	N or S
4A	4B	Solder Lug	30°	01 to 04	100	02 to 12	N or S

FEATURES

- Easy Temporary Connections
- Binding Post Security
- Push Post Speed
- Tension Adjustable Test Clips
- Special Fit PC Mount Sockets

Binding Posts

Straight Skirt, Flared Skirt, Dual Base Series 29 G-3

Push Posts

Standard, Insulated, & Banana Plug Styles Series 29 G-4

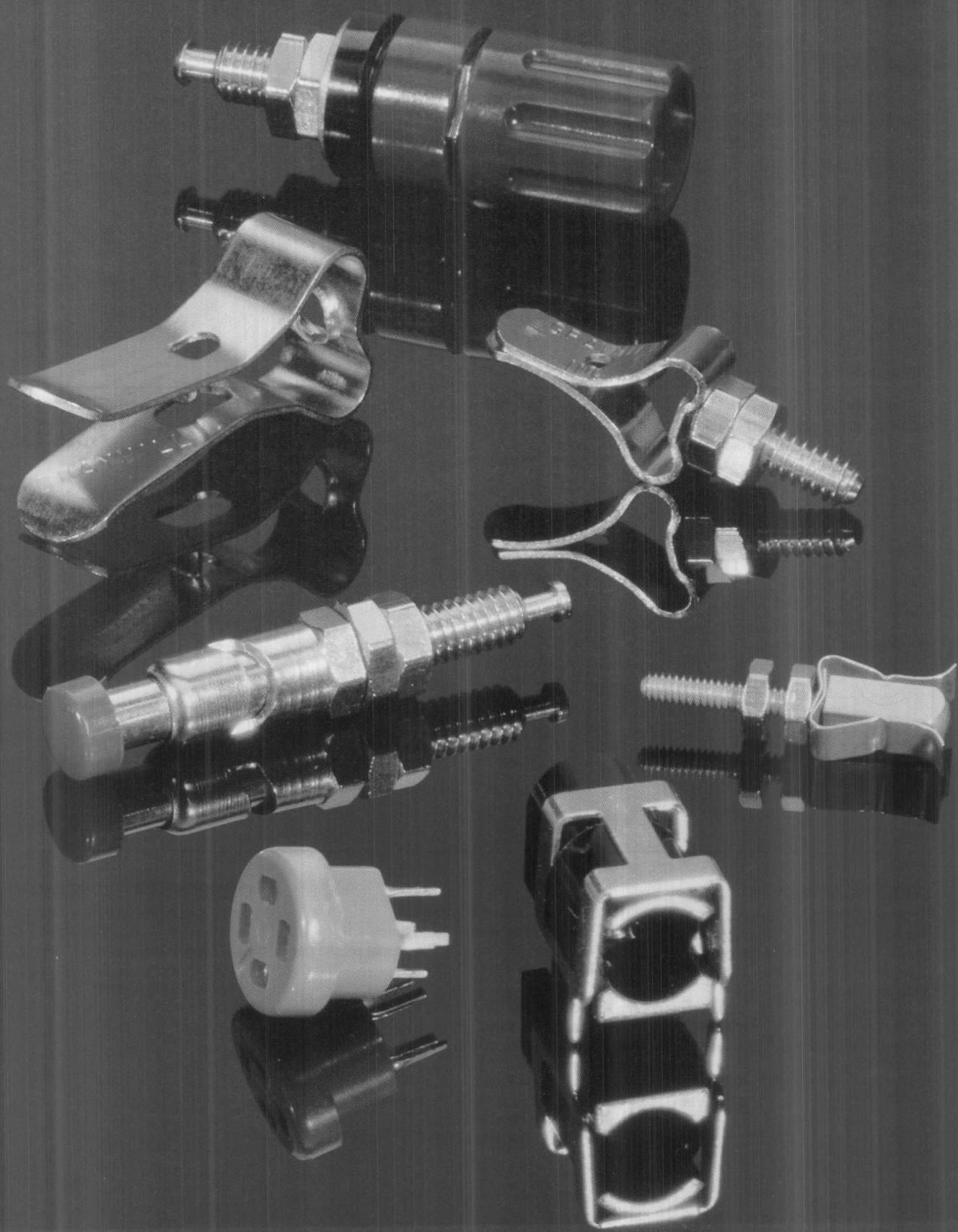
Test Clips

Standard, Miniature, & Ultra Miniature Series 2 G-5

Sockets

Transistor Sockets Series 22 G-6

Lamp Sockets Series 22 G-6

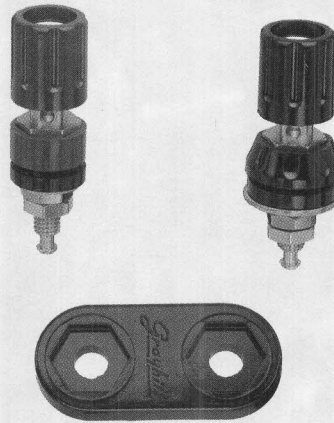


BINDING POSTS

SERIES 29

FEATURES

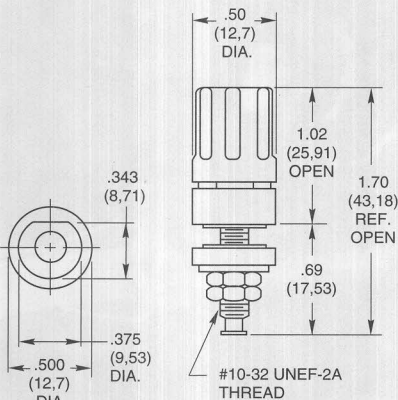
- Flush Hole to Prevent Crimping
- Space-Saving 3/8" Diameter or Decorative Flared Skirt
- Dual Mounting Base Accessory



DIMENSIONS In Inches (and millimeters)

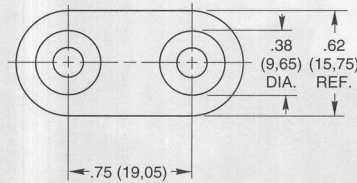
Straight Skirt Style 29-1 BLK and 29-1 RED

Screw post fits 3/8" (9,53) diameter hole for close spacing.



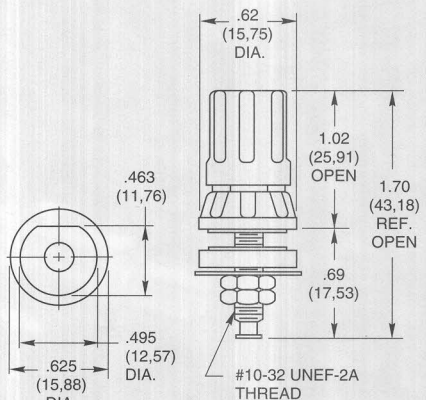
Dual Mounting Base 29B11-1

For use with 29-1 BLK and 29-1 RED
Mounting base is black.



Flared Skirt Style 29-3 BLK and 29-3 RED

Screw post fits 1/2" (12,7) diameter hole for wider spacing.



SPECIFICATIONS

Rating Criteria

Rating: At 120 Vdc, 15 Amps continuously, with a maximum temperature rise of 20°C.

Insulation Resistance: Between stud and mounting panel

For 29-1 styles	120,000 megohms
For 29-3 styles	200,000 megohms

Voltage Breakdown: Between studs and mounting panel

For 29-1 styles	1500 Vac
For 29-3 styles	3000 Vac

Materials and Finishes

Metal Parts: Nickel plated brass

Insulating Materials: Thermoset plastic per MIL-M-14, Type CFG

Additional Characteristics

Insulating Washers: Non-turn "D" style

Solder Stud: Integral; 2 hex nuts for solder lug connections

Heads: Captive

Cross Hole: Flush to stud extension to eliminate cutting or crimping wires

Panel Thickness: Up to 3/16" (4,76)

ORDERING INFORMATION

Order using part numbers shown in dimensions.

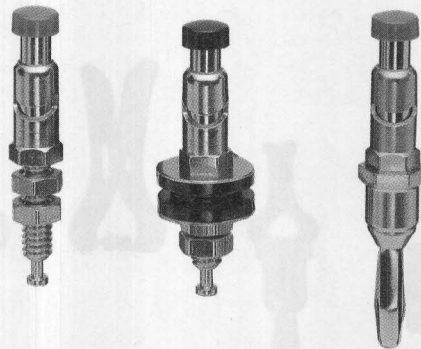
Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 29

FEATURES

- Quick Connect/Disconnect
- Only 7/8" Above Board Height
- Standard, Insulated, or Banana Plug Styles
- High Temperature Spring Style
- Color Coded Caps With Optional Additional Colors

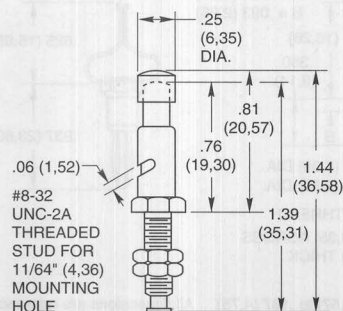


DESCRIPTION

Press button and put lead in slot and release. Spring pressure assures firm, positive contact.

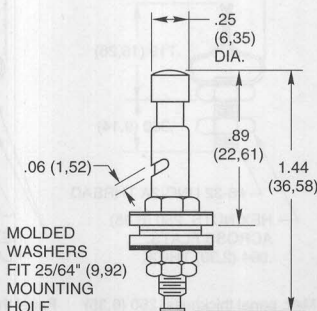
DIMENSIONS In Inches (and millimeters)

Standard Style



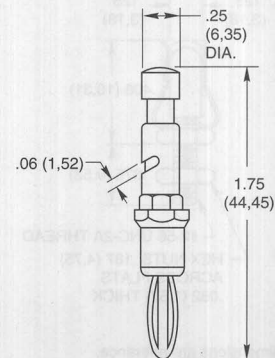
Red/Black cap **Part No. 29-100**
No cap **Part No. 29-110**
No cap, high temp. **Part No. 29-125**

Insulated Style



Same as 29-100 with Black Thermoset Plastic Washers **Part No. 29-104**

Banana Plug Style



Fits Standard Banana Socket **Part No. 29-101**

SPECIFICATIONS

Rating Criteria

Rating: At 120 Vdc, 20 Amps continuously, with a maximum temperature rise of 20°C.

Materials and Finishes

External Metal Parts: Nickel plated brass

Spring: Tinned music wire

Button Caps: Polyethylene

Washers (29-104): Black thermoset plastic

High Temperature Spring: Stainless steel

OPTIONS

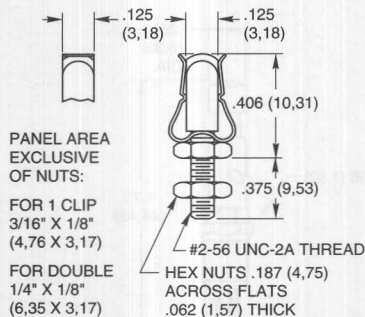
Green or White Caps

Gold plate finish: Available on all but Banana Plug styles.

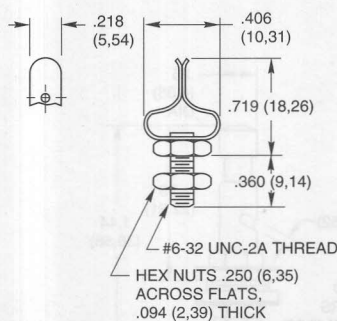
ORDERING INFORMATION

Description	Part Number
Standard, without cap	29-110
Standard, with red cap	29-100 RED
Standard, with black cap	29-100 BLK
High temperature standard, without cap	29-125
Insulated, with black cap	29-104 BLK
Insulated, with red cap	29-104 RED
Banana plug, with black cap	29-101 BLK
Banana plug, with red cap	29-101 RED

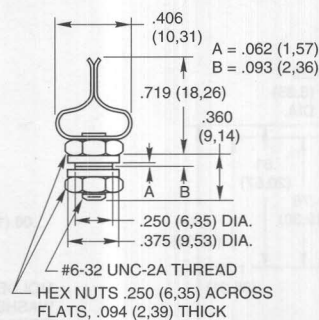
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

DIMENSIONS In Inches (and millimeters)**Ultra Miniature
2-41 and 2-42**

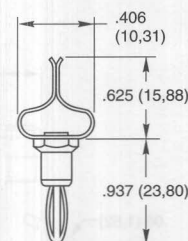
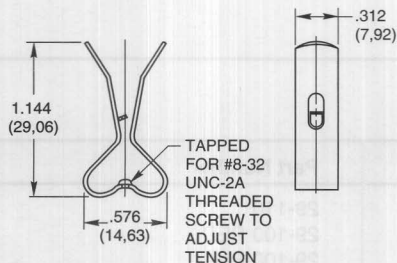
All dimensions are reference.

**2-20
Threaded Stud**

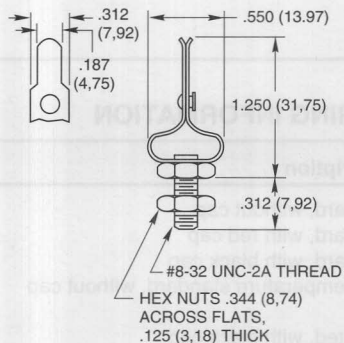
Max. panel thickness .250 (6,35)

**Miniature
2-24
Insulated**

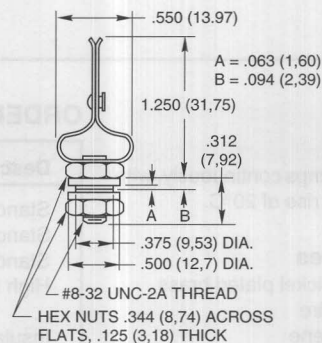
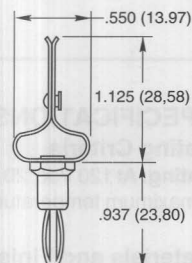
Panel thickness .062 (1,57) to .187 (4,75) All dimensions are reference.

**2-21
Standard Banana Plug****Standard Size Threadless
2-60**SCREW NOT
INCLUDED

All dimensions are reference.

**2-0
Threaded Stud**

Max. panel thickness .250 (6,35)

**Standard Size
2-4
Insulated****2-1
Standard Banana Plug**

All dimensions are reference.

STANDARD OPTIONS

Standard Size Threaded Stud Clip can be made of Stainless Steel or Inconel X material.
Not available through Distributors.

SPECIFICATIONS**Materials and Finishes**

Studs: Nickel plated steel except for 2-41 and 2-42 which are nickel plated brass

Rivets and Nuts: Nickel plated brass

Spring Clips: Nickel plated brass except for 2-41 and 2-42 which are nickel plated beryllium copper

Insulators: Thermoset Plastic

ORDERING INFORMATION

Order using part numbers shown in dimensions.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SERIES 22

TRANSISTOR SOCKET FEATURES

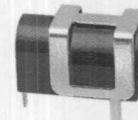
- Sockets for JETEC Transistors & Similar Packaged Devices

LAMP SOCKET FEATURES

- Sockets for the Popular Sizes Of Miniature Lamps
- Secondary Use: Pencil Tube Socket



Transistor Sockets

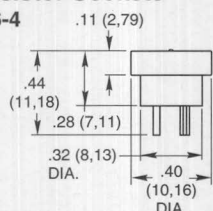


Bi-Pin Lamp Sockets

DIMENSIONS In Inches (and millimeters)

Transistor Sockets

22-16-4

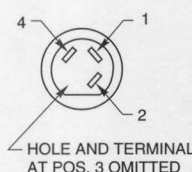


Terminal numbers are molded into bottom.

Indicator for aligning transistor tab is molded into top.

Solder socket into PC board or mount through a "D" shaped hole and use retaining ring. See Specifications.

22-16-3

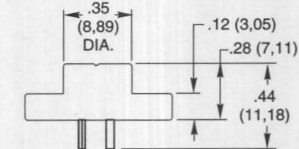
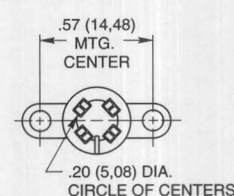


22-16-2



Transistor Sockets

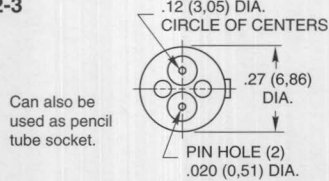
22-11



Fits through 3/16" diameter hole.

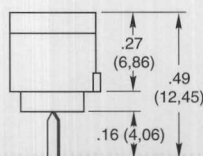
Bi-Pin Lamp Sockets

22-3



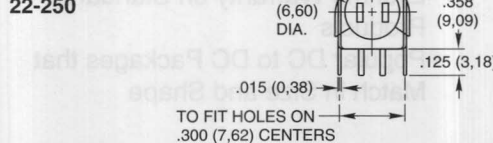
Can also be used as pencil tube socket.

Trim Lamp leads to .215 (5,46) length.

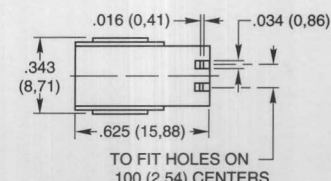
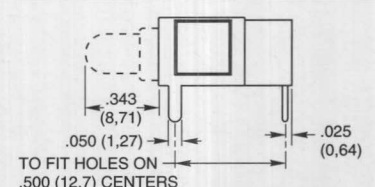
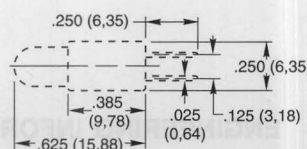


Bi-Pin Lamp Sockets

22-250



LAMPS-NOT SUPPLIED
Trim Lamp leads to .215 (5,46) length



SPECIFICATIONS

Ratings, Transistor Sockets

Operating Temperature: 265°F maximum

Loss Factor: .06 at 1 Meg

Materials/Finishes, Transistor Sockets

Contacts: Wrap-around type, silver plated beryllium copper with gold plate

Housing: Natural color, mica filled thermoset plastic per MIL-M-15, type MFE.

Recommended Clip Mounting: Use a Walde Truarc retaining ring, number #115-31.

Recommended Rivet and Screw Mounting: Rivets or #2 screws.

Materials/Finishes, Lamp Sockets

Insulating Material: Mica filled thermoset plastic per MIL-M14 type MFE for part 22-3; and thermoset plastic for part 22-250.

Saddle (For 22-250): Lead tin plated brass.

Contacts (For 22-250): Gold plated beryllium copper

ORDERING INFORMATION

Socket Description	Transistor or Lamp Type (Not Provided)	Part Number
Transistor Sockets		
3-Pin Clip Mount, Flat between pins	TO-5, 9, 11, 16, 26, 29, 31, & 39	22-16-2
3-Pin Clip Mount, Flat opposite pins	TO-5, 9, 11, 16, 26, 29, 31, & 39	22-16-3
4-Pin Clip Mount Transistor Socket	TO-12 & 33	22-16-4
4-Pin Screw or Rivet Mount	TO-12 & 33	22-11
Bi-Pin Lamp Sockets		
Perpendicular Mount	T-1-3/4 or Chicago Min. T-1-1/4	22-3
Right Angle Mount	T-1-3/4	22-250

OPTION

Part number 22-11 is available with 3 terminals.

Option not available through Distributors

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

SOLID STATE RELAYS

- Excellent Transient Protection
- High Surge Current Capability
- Optically Isolated
- Rigid Inspection and Process Control
- High Blocking Voltage
- Extremely Long Life
- Miniature but Mighty; Up to 25A
- Lifetime Warranty on Standard Products
- Popular DC to DC Packages that Match in Size and Shape

ENGINEERING INFORMATION

Engineering Information H-3

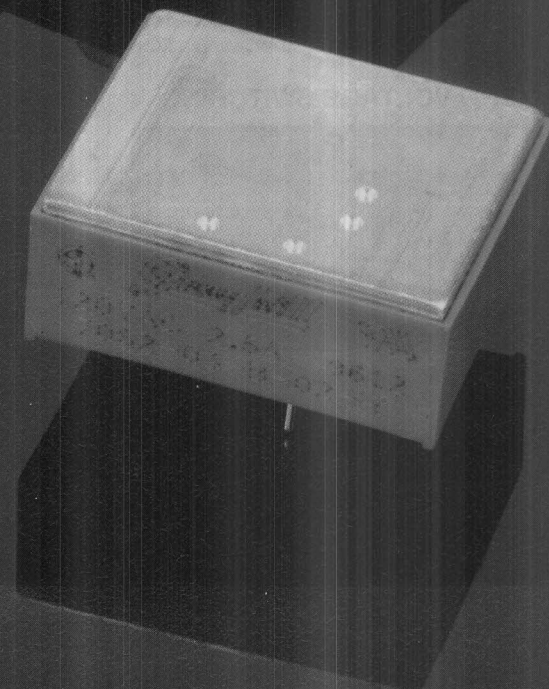
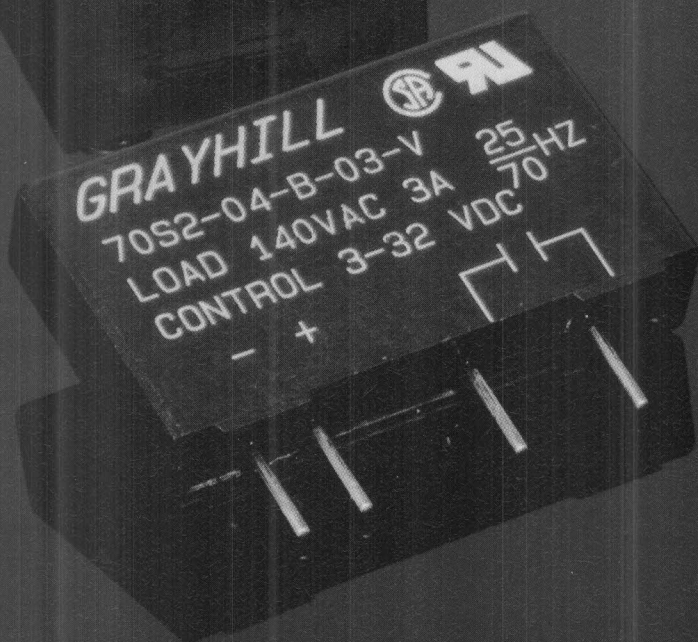
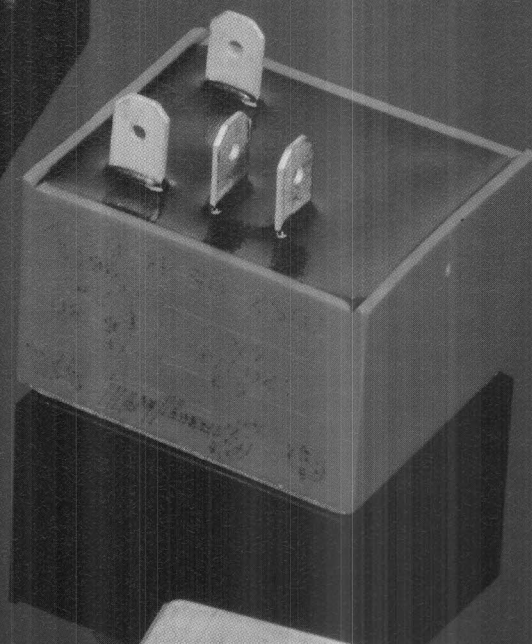
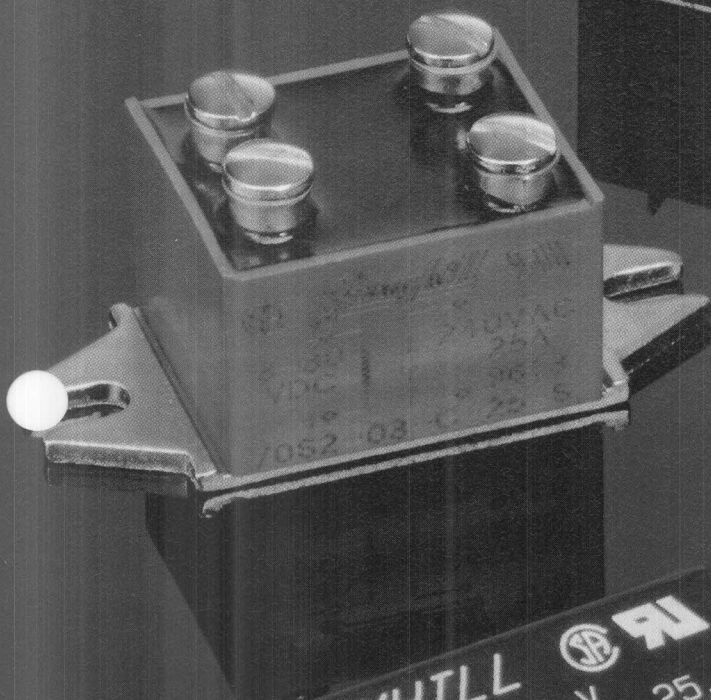
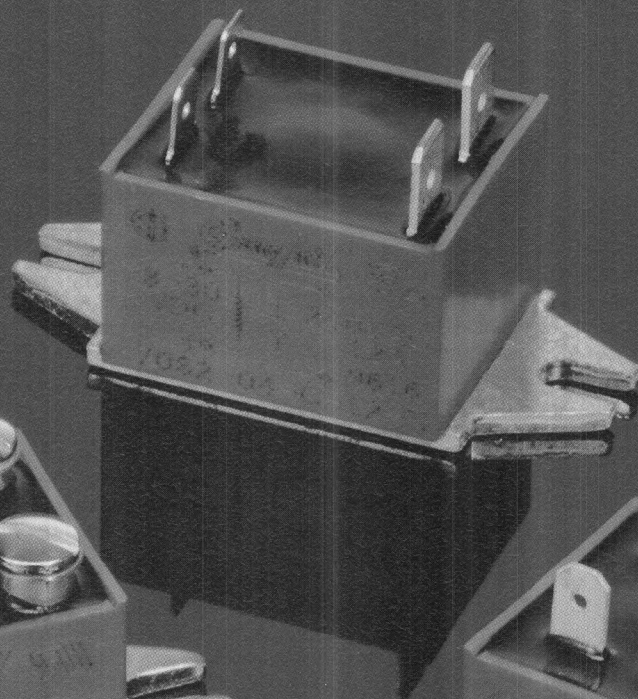
SELECTION H-4

DC TO AC SOLID STATE RELAYS

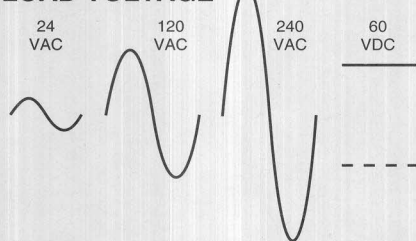
Vertical, Single In-Line Package	Style V	H-5
Low Profile Micro Cube Relay	Style H	H-6
Mini Cube Relays	Style F and K	H-7
Extended Current Micro and Mini Cubes	Style L and M	H-9
Mini Puck Panel Mount Relays	Style N and S	H-11

DC TO DC SOLID STATE RELAYS

Popular Package Outline Relays Styles V, F, K, N, S H-13



LOAD VOLTAGE

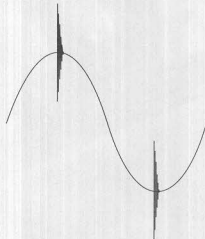


Solid State Relays are specifically designed to switch either AC or DC loads. Those intended to switch AC loads come in three standard varieties: 24 Vac, 120 Vac, and 240 Vac. The ranges of AC voltages that these relays are capable of switching are 10 to 50 Vac, 24 to 140 Vac, and 24 to 280 Vac respectively. The frequency of the AC voltage can vary from 25 to 70 Hz without impacting the relay operation.

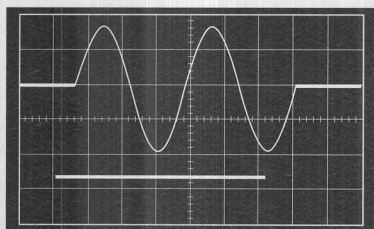
DC relays switch loads in the 3 to 60 Vdc range. Relays for switching up to 200 Vdc are also available. Consult Grayhill for more information. All standard relays have form A, N.O. contacts.

VOLTAGE TRANSIENTS

Transients or spikes on AC power lines are not uncommon. Lightning strikes, power surges, and switching of heavy inductive loads are some typical causes. Extremely high voltage magnitudes or fast rates of rise may result in false triggering of some solid state relays. However, Grayhill provides a built-in snubber network and unique circuit design to prevent false operation during voltage transients as fast as 3000 volts per microsecond. High blocking voltages of 400 volts (120 Vac relays) and 600 volts (240 Vac relays) provide additional protection. Compare these ratings with those of relays from other manufacturers.

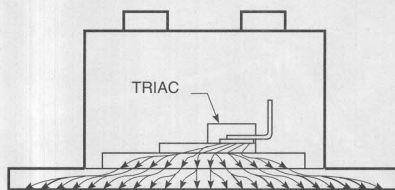


ZERO VOLTAGE SWITCHING



Standard AC relays have a zero voltage turning on circuit which prevents the relay from turning on until the voltage across the load is at or near zero, hence the name "zero crossing relay". This feature has many benefits. Along with reducing the amount of EMI/RFI generated, it also eliminates high in-rush currents to the load. In many cases this can significantly improve the life expectancy of the load. It is also worth noting that a solid state relay turns off at zero current.

LOAD CURRENT

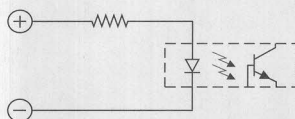


THERMAL SPREADING OF PYRAMID HEAT FLOW DESIGN

The load current rating indicates the full rated load the relay will carry continuously. This rating is established by monitoring the semiconductor junction temperatures under increasing load current conditions. Grayhill sets its current ratings to guarantee that the semiconductor junction temperatures do not exceed 100°C in dead air (moving air improves load capacity). As ambient temperature is increased, load current is derated to maintain the 100°C junction temperature. Maximum load current vs. ambient temperature curves for each relay are shown on the product pages.

Equally important in some applications is the minimum load current requirement. This is the amount of load current required to keep a relay on once it has been triggered. This current is typically 50 to 100 mA. When switching very low current loads it may be necessary to connect a resistor in parallel with the load to boost the load current above the minimum.

CONTROL VOLTAGE AND



CURRENT

The input circuit of a typical relay consists of an input resistor in series with the light emitting portion of an optocoupler. The input resistor value (approximated by the average input impedance specification) determines the input voltage and current levels required to turn the relay on and off. Either the positive (+) or negative (-) input terminal can be switched to control the relay. Grayhill offers two standard average input impedance options: 2000 ohms and 6000 ohms.

QUALITY

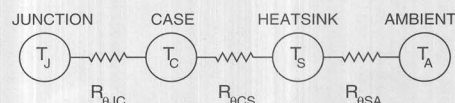
Quality is a measure of how well our products' performance matches your expectations. Our standard for quality is simple: zero defects. Statistical process control check points are found all along the production line to determine variability from one lot to the next.

TESTING

All major electrical parameters are tested on every Grayhill relay just before shipping. Datalogged information from this testing is available to reduce the incoming inspection time at your facility. In addition, burn-in testing is performed on random samples from each lot.

MOUNTING AND HEATSINKING

In applications where 4 amps or less are being switched, the relay may be mounted directly on the PC board without any supplemental heatsinking. Package styles H, V, F, or K are suited for these applications. When switching currents greater than 5 amps, some amount of supplementary heatsinking will most likely be required. The L, M, N, and S package styles come with bulk head heatsinks to accommodate mounting to a supplemental heatsink.



Calculating the size of the supplemental heatsink required to keep the semiconductor junctions under 100°C is fairly simple. The diagram above is a model of the thermal circuit of a relay. Heat is generated by the relay when it is switching current. The materials used and square area available to dissipate this heat determine how much heat flow will be impeded. R_{θ} is a measure of resistance to heat flow of each component in the thermal circuit. Assuming thermal grease is applied to the relay prior to mounting, the equation below calculates the required maximum $R_{\theta SA}$ of the supplemental heatsink.

$$R_{\theta SA} = [100^{\circ}\text{C} - T_A - (P_D \times R_{\theta JC})] \div P_D$$

T_A is the ambient temperature around the relay. P_D can be found by multiplying your load current times the Typical Power Dissipation specifications shown on the product pages. $R_{\theta JC}$ for each type of relay can also be found there.

Below is a chart of approximate $R_{\theta SA}$ for different heatsink types:

Heatsink Type	$R_{\theta SA}$
6" x 6" x 1/8" aluminum sheet	2.4°C/W
12" x 12" x 1/8" aluminum sheet	1.2°C/W
3" x 1" x 1" finned aluminum sink	4.2°C/W

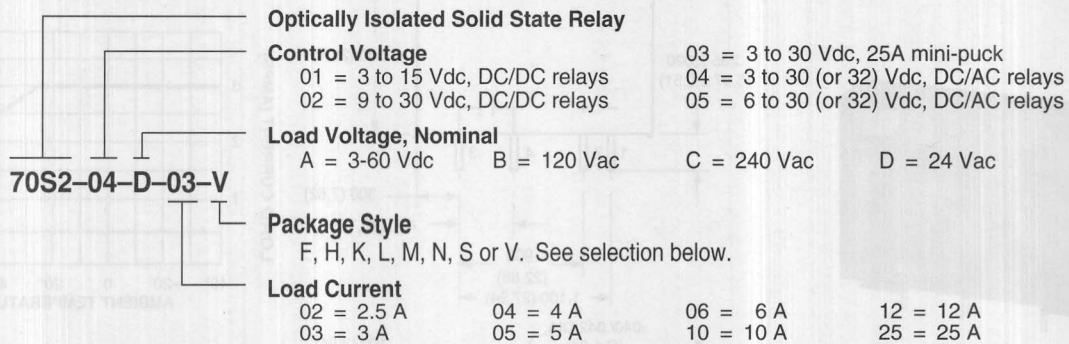
SPECIAL RELAY DESIGNS

Let us know if you have special switching needs. We have designed hundreds of custom solid state relays. The following options are typical: non-zero crossing, different terminations, higher blocking voltage, varying input voltage ranges, and normally closed versions.

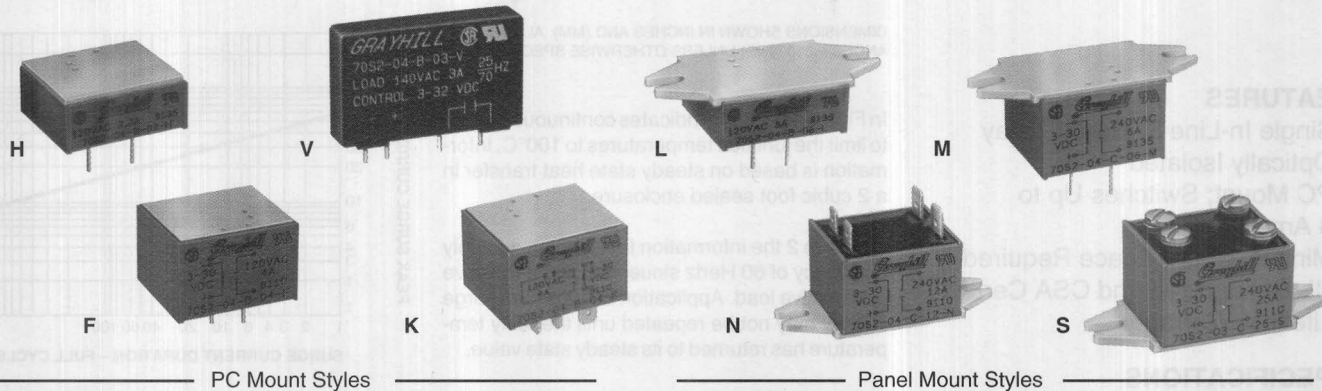
RELIABILITY

Unlike electro-mechanical relays, Solid State Relays have no moving parts to wear out. Load switching is performed by semiconductor devices resulting in extremely long life. Grayhill Solid State Relay designs minimize parts count, use only the highest grade components, and provide efficient thermal management for cooler semiconductor junction temperatures. Grayhill performs ongoing accelerated life testing to calculate the mean time before failure (MTBF) of our relays. Request a copy of the *Solid State Reliability Report* for more information.

PART NUMBER EXPLANATION



SELECTION



DC Switching AC

Max. Load Current	Control Voltage	Nominal Load Voltage	Description And Features	Style	Page
2.5A	3-30 or 6-30 Vdc	24, 120, or 240 Vac	Micro Cube® Relay, Only .500" High	H	H-6
3A	3-32 or 6-32 Vdc	24, 120, or 240 Vac	Single In-Line Package, Uses Only .680 Sq. Inches Board Area	V	H-5
4A	3-30 or 6-30 Vdc	24, 120, or 240 Vac	Mini Cube Relay, PC Mount	F	H-7
4A	3-30 or 6-30 Vdc	24, 120, or 240 Vac	Mini Cube Relay, Plugs Into Socket	K	H-7
6A	3-30 or 6-30 Vdc	120, or 240 Vac	Use Heat Sink or Panel Mount	L	H-9
6A	3-30 or 6-30 Vdc	120, or 240 Vac	Use Heat Sink or Panel Mount	M	H-9
6A	3-30 or 6-30 Vdc	120, or 240 Vac	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Tab Terminals	N	H-11
6A	3-30 or 6-30 Vdc	120, or 240 Vac	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Screw Terminals	S	H-11
10A	3-30 or 6-30 Vdc	120, or 240 Vac	Use Heat Sink or Panel Mount	M	H-9
12A	3-30 or 6-30 Vdc	120, or 240 Vac	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles Tab Terminals	N	H-11
12A	3-30 or 6-30 Vdc	120, or 240 Vac	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Screw Terminals	S	H-11
25A	3-30 Vdc	120, or 240 Vac	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Screw Terminals	S	H-11

DC Switching DC

3A	3-15 or 9-30 Vdc	3 to 60 Vdc	Single In-Line Package, Uses Only .680 Sq. Inches Board Area	V	H-13
3A	3-15 or 9-30 Vdc	3 to 60 Vdc	Mini Cube Relay, PC Mount	F	H-13
3A	3-15 or 9-30 Vdc	3 to 60 Vdc	Mini Cube Relay, Plugs Into Socket	K	H-13
5A	3-15 Vdc	3 to 60 Vdc	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Tab Terminals	N	H-13
5A	3-15 Vdc	3 to 60 Vdc	Mini Puck® Relays, Panel Mount, Fit/Function Replacements for Larger Hockey Puck Styles, Screw Terminals	S	H-13

FEATURES

- Single In-Line Package Relay
- Optically Isolated
- PC Mount; Switches Up to 3 Amps
- Minimal Board Space Required
- UL Recognized and CSA Certified
- Lifetime Warranty

SPECIFICATIONS

Output Circuit

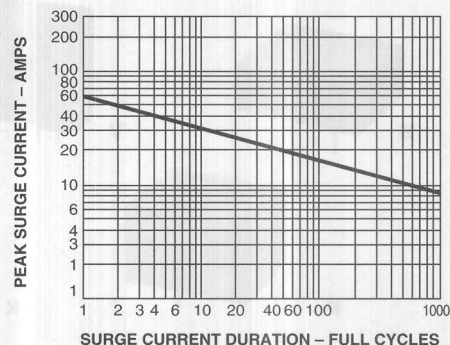
Nominal Line Voltage (Vac):	24	120	240
Load Voltage Range (Vac):	10-50	24-140	24-280
Minimum Peak Blocking Voltage (Volts):	200	400	600
Maximum Zero Voltage Offset (Volts):	16	18	28
Max. Off State Leakage Current 60 Hz (mA rms):	4	6	6
Load Current Range: 65 mA to 3 Amps rms. See Figure 1 for derating.			
One Cycle Surge Current: 60 Amps peak maximum. See Figure 2 for derating.			
Static dV/dT: 3000 V/microsecond typical, measured under open circuit conditions. Not to exceed peak blocking voltage.			
Load Power Factor Range: 0.5 to 1.0			
Frequency Range: 25 to 70 Hz			

DIMENSIONS SHOWN IN INCHES AND (MM). ALL TOLERANCES ± 0.010 (0.25) UNLESS OTHERWISE SPECIFIED.

In Figure 1 the chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

In Figure 2 the information is based on a supply frequency of 60 Hertz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the relay temperature has returned to its steady state value.

Surge Duration



On State Voltage Drop: 1.5V peak maximum
Thermal Resistance (Junction to Ambient): 25°C/Watt
Typical Power Dissipation: 1 Watt/Amp
Turn-On Time (60 Hz): 8.3 mS maximum
Turn-Off Time (60 Hz): 8.3 mS maximum
I²t For Fusing (t = 8.3 mS): 26.5 Amp²Sec minimum

Input Circuit

Control Voltage Range (Vdc):	3-32	6-32
Control Current Range (mA):	1.0-19.0	1.0-6.0
Ave. Input Impedance (Ohms):	2000	6000
Min. Drop Out Voltage (Vdc):	1.0	1.0
Max. Reverse Control Voltage (Vdc):	5	5

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): 10⁹ ohms minimum
Dielectric Strength (Input to Output): 3000 Vrms minimum
Capacitance (Input to Output): 6 pF typical
Vibration: 20 g's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D
Mechanical Shock: 1500 g's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F
Operating Temperature Range: -40° to +100°C
Storage Temperature Range: -40°C to +125°C
Weight: 25 grams maximum

Materials and Finishes

Terminals: Copper wire, Tin plated
Case: Solvent resistant thermoplastic, Polyester, meets UL94V-0
Potting: High thermal conductive epoxy

All specifications apply over the operation temperature range.

ORDERING INFORMATION

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
24	3A	3-32	70S2-04-D-03-V
24	3A	6-32	70S2-05-D-03-V
120	3A	3-32	70S2-04-B-03-V
120	3A	6-32	70S2-05-B-03-V
240	3A	3-32	70S2-04-C-03-V
240	3A	6-32	70S2-05-C-03-V

Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

UL file number E58632 and CSA file number LR38763 apply to all relays shown here.

This style is also available in DC to DC relays. See page H-13.

STYLE H

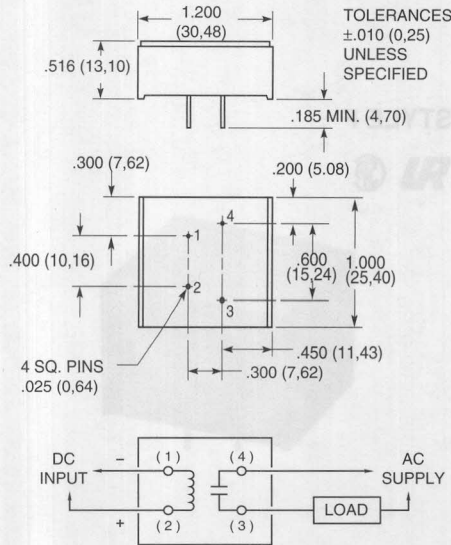
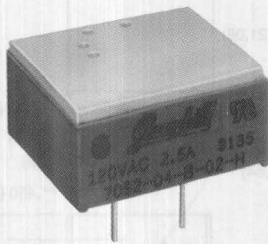


Figure 1: Maximum Continuous Current vs. Ambient Temperature

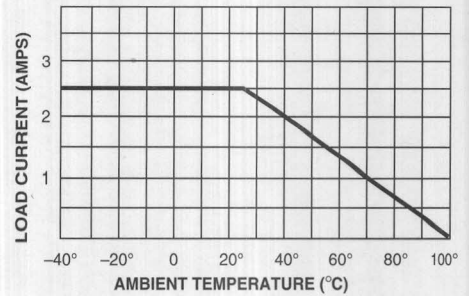
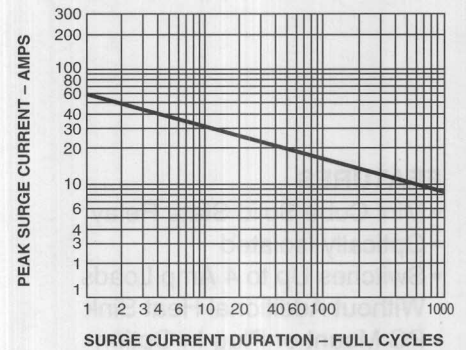


Figure 2: Maximum Peak Surge Current vs. Surge Duration



FEATURES

- Micro Cube® Solid State Relay
- Optically Isolated
- PC Mount; Only .5" Above Board
- Minimal Board Space Required
- UL Recognized and CSA Certified
- Lifetime Warranty

SPECIFICATIONS

Output Circuit			
Nominal Line Voltage (Vac):	24	120	240
Load Voltage Range (Vac):	10-50	24-140	24-280
Minimum Peak Blocking Voltage (Volts):	200	400	600
Maximum Zero Voltage Offset (Volts):	6	8	18
Max. Off State Leakage Current 60 Hz (mA rms):	4	6	6
Load Current Range: 75 mA to 2.5 Amps rms. See Figure 1 for derating.			
One Cycle Surge Current: 60 Amps peak maximum. See Figure 2 for derating.			
Static dV/dT: 3000 V/microsecond typical, measured under open circuit conditions. Not to exceed peak blocking voltage.			
Load Power Factor Range: 0.5 to 1.0			
Frequency Range: 25 to 70 Hz			

On State Voltage Drop: 1.5V peak maximum
Thermal Resistance (Junction to Ambient): 22°C/Watt
Typical Power Dissipation: 1 Watt/Amp
Turn-On Time (60 Hz): 8.3 mS maximum
Turn-Off Time (60 Hz): 8.3 mS maximum
I²t For Fusing (t = 8.3 mS): 26.5 Amp²Sec minimum

Input Circuit		
Control Voltage Range (Vdc):	3-30	6-30
Control Current Range (mA):	1.0-18.0	1.0-6.0
Ave. Input Impedance (Ohms):	2000	6000
Min. Drop Out Voltage (Vdc):	1.0	1.0
Max. Reverse Control Voltage (Vdc):	5	5

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): 10⁹ ohms minimum
Dielectric Strength:

(Input to Output): 2500 Vrms minimum
 (Input or Output to Case): 3000 Vrms minimum

Capacitance (Input to Output): 6 pF typical

Vibration: 20 g's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D

Mechanical Shock: 1500 g's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F

Operating Temperature Range: -40° to +100°C

Storage Temperature Range: -40°C to +125°C

Weight: 22 grams maximum

Materials and Finishes

Terminals: Copper wire, Tin plated

Case: Solvent resistant thermoplastic, Polyester, meets UL94V-0

Potting: High thermal conductive epoxy

Heat Sink: Aluminum

All specifications apply over the operation temperature range.

ORDERING INFORMATION

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
24	2.5A	3-30	70S2-04-D-02-H
24	2.5A	6-30	70S2-05-D-02-H
120	2.5A	3-30	70S2-04-B-02-H
120	2.5A	6-30	70S2-05-B-02-H
240	2.5A	3-30	70S2-04-C-02-H
240	2.5A	6-30	70S2-05-C-02-H

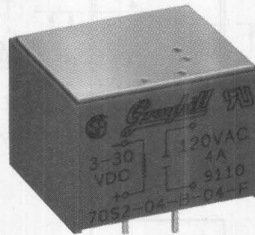
Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

UL file number E58632 and CSA file number LR38763 apply to all relays shown here.

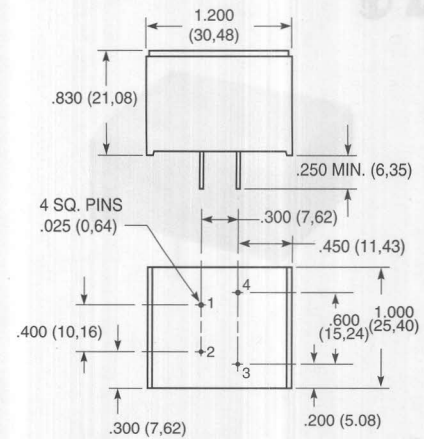
For relays with this footprint for larger loads, see page H-7.

DC/AC SOLID STATE RELAYS

STYLE F



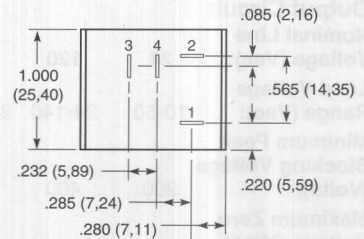
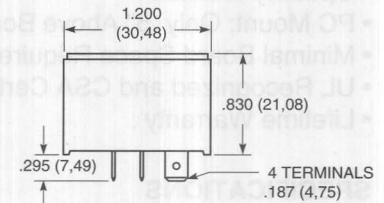
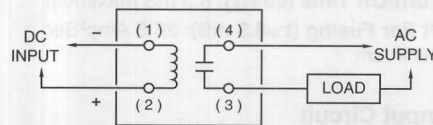
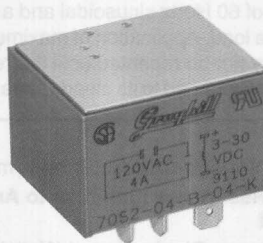
DIMENSIONS ARE SHOWN IN INCHES (AND MILLIMETERS). ALL TOLERANCES $\pm .010$ (0,25) UNLESS OTHERWISE SPECIFIED



FEATURES

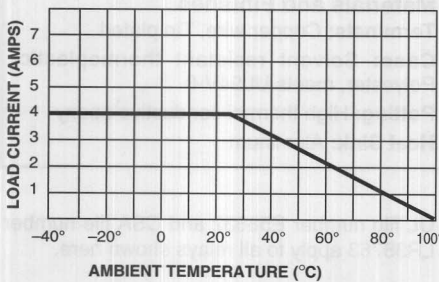
- Mini Cube Solid State Relay
- Optically Isolated
- Switches Up to 4 Amp Loads Without Additional Heat Sink
- PC Mount or Plug-In Option
- UL Recognized and CSA Certified
- Lifetime Warranty

STYLE K



TERMINALS OF STYLE K FIT STANDARD SOCKET OR PUSH ON TABS. SOCKETS ARE IDEC PART NUMBERS SH2B-51, SH2B-62, SH2B-02 OR EQUIVALENTS.

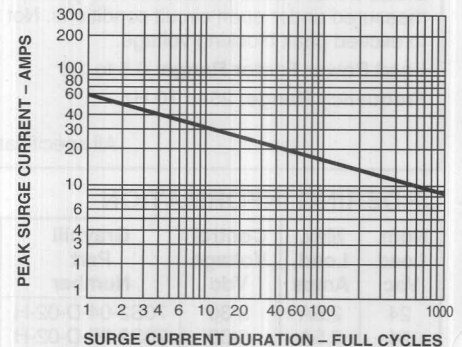
Figure 1: Maximum Continuous Current vs. Ambient Temperature



In Figure 1 the chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

In Figure 2 the information is based on a supply frequency of 60 Hertz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the relay temperature has returned to its steady state value.

FIGURE 2: MAXIMUM PEAK SURGE CURRENT VS. SURGE DURATION



SPECIFICATIONS

Output Circuit

Nominal Line Voltage (Vac):	24	120	240
Load Voltage Range (Vac):	10-50	24-140	24-280
Minimum Peak Blocking Voltage (Volts):	200	400	600
Maximum Zero Voltage Offset (Volts):	6	8	18
Max. Off State Leakage Current 60 Hz (mA rms):	4	6	6

Load Current Range: 75 mA to 4 Amps rms. See Figure 1 for derating.

One Cycle Surge Current: 60 Amps peak maximum. See Figure 2 for derating.

Static dV/dT: 3000 V/microsecond typical, measured under open circuit conditions. Not to exceed peak blocking voltage.

Load Power Factor Range: 0.5 to 1.0

Frequency Range: 25 to 70 Hz

On State Voltage Drop: 1.5V peak maximum

Thermal Resistance (Junction to Ambient): 15°C/Watt

Typical Power Dissipation: 1 Watt/Amp

Turn-On Time (60 Hz): 8.3 mS maximum

Turn-Off Time (60 Hz): 8.3 mS maximum

I²t For Fusing (t = 8.3 mS): 26.5 Amp²Sec minimum

Input Circuit

Control Voltage Range (Vdc):	3-30	6-30
Control Current Range (mA):	1.0-18.0	1.0-6.0
Ave. Input Impedance (Ohms):	2000	6000
Min. Drop Out Voltage (Vdc):	1.0	1.0
Max. Reverse Control Voltage (Vdc):	5	5

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): 10⁹ ohms minimum

Dielectric Strength:

(Input to Output): 3000 Vrms minimum

(Input or Output to Case): 3000 Vrms min.

Capacitance (Input to Output): 6 pF typical

Vibration: 20 g's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D

Mechanical Shock: 1500 g's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F

Operating Temperature Range:

-40° to +100°C

Storage Temperature Range:

-40°C to +125°C

Weight: 35 grams maximum

Materials and Finishes

Tab Terminals, Style K: Brass, Lead-Tin plated

PC Terminals, Style F: Copper wire, Lead-Tin plated

Case: Solvent resistant thermoplastic, Polyester, meets UL94V-0

Potting: High thermal conductive epoxy

Heat Sink: Aluminum

UL Recognition and CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all relays shown here.

All specifications apply over the operation temperature range.

ORDERING INFORMATION

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
MINI CUBE RELAY, PC MOUNT STYLE F			
24	4A	3-30	70S2-04-D-04-F
24	4A	6-30	70S2-05-D-04-F
120	4A	3-30	70S2-04-B-04-F
120	4A	6-30	70S2-05-B-04-F
240	4A	3-30	70S2-04-C-04-F
240	4A	6-30	70S2-05-C-04-F
MINI CUBE RELAY, PLUG-IN STYLE K			
24	4A	3-30	70S2-04-D-04-K
24	4A	6-30	70S2-05-D-04-K
120	4A	3-30	70S2-04-B-04-K
120	4A	6-30	70S2-05-B-04-K
240	4A	3-30	70S2-04-C-04-K
240	4A	6-30	70S2-05-C-04-K

Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

These styles are also available in DC to DC solid state relays. See page H-13.

FEATURES

- Micro Cube® Mini Cube Relays With Extended Current Ratings
- PC Mount; Optically Isolated
- Integral Heat Sink Accommodates Panel Mount or Add-On Heat Sink
- Switches Up to 6 or 10 Amp Loads
- UL Recognized and CSA Certified
- Lifetime Warranty

STYLE M

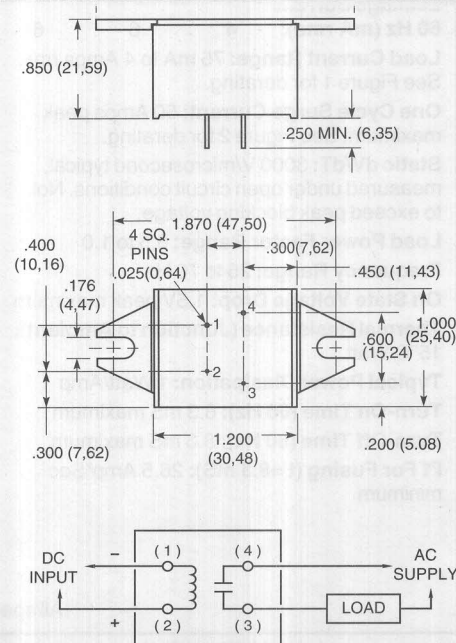
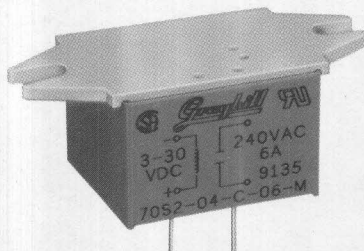
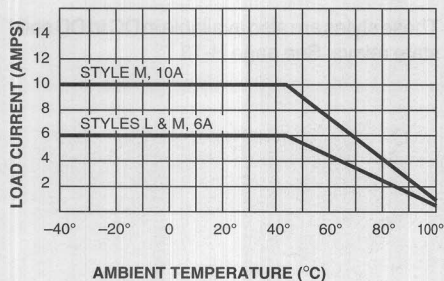


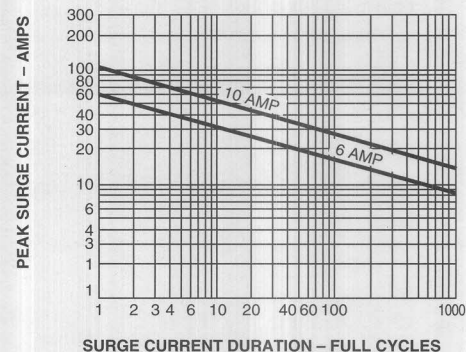
Figure 1: Maximum Continuous Current vs. Ambient Temperature



In Figure 1 the chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on the use of a 12" x 12" x 1/8" aluminum heatsink (with silicon grease) in a 2 cubic foot sealed enclosure.

In Figure 2 the information is based on a supply frequency of 60 Hertz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the relay temperature has returned to its steady state value.

Figure 2: Maximum Peak Surge Current vs. Surge Duration



SPECIFICATIONS

Output Circuit

Nominal Line Voltage (Vac):	120	240
Load Voltage Range (Vac):	24-140	24-280
Minimum Peak Blocking Voltage (Volts):	400	600
Maximum Zero Voltage Offset (Volts):	8	18
Max. Off State Leakage Current 60 Hz (mA rms):	6	6
Max Load Current (Amps rms):	6	10
Load Current Range (Amps rms): See Figure 1.	.075-6	.075-10
Max. 1 Cycle Surge Current (Amps Peak): See Figure 2.	60	110
Typical Power Dissipation (Watts/Amp):	1.1	1.2
Thermal Resistance (Junction to Ambient)		
Style L	4.6°C/Watt	
Style M:	4.2°C/Watt	3.3°C/Watt
Minimum I ² t For Fusing (Amp ² Sec at 8.3 mS):	26.5	50.0

Static dV/dT: 3000 V/microsecond typical, measured under open circuit conditions. Not to exceed peak blocking voltage.

Frequency Range: 25 to 70 Hz

On State Voltage Drop: 1.5V peak maximum

Turn-On Time (60 Hz): 8.3 mS maximum

Turn-Off Time (60 Hz): 8.3 mS maximum

Input Circuit

Control Voltage Range (Vdc):	3-30	6-30
Control Current Range (mA):	1.0-18.0	1.0-6.0
Ave. Input Impedance (Ohms):	2000	6000
Min. Drop Out Voltage (Vdc):	1.0	1.0
Max. Reverse Control Voltage (Vdc):	5	5

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): 10⁹ ohms minimum

Dielectric Strength (Input to Output):

2500 Vrms minimum—L Style

3000 Vrms—M Style

(Input or Output to Case): 3000 Vrms min.

Capacitance (Input to Output): 6 pF typical

Vibration: 20 g's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D

Mechanical Shock: 1500 g's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F

Operating Temperature Range:

-40° to +100°C

Storage Temperature Range:

-40°C to +125°C

Weight, Style L: 30 grams maximum

Weight, Style M: 60 grams maximum

Materials and Finishes

PC Terminals: Copper wire, Lead-Tin plated

Case: Solvent resistant thermoplastic, Polyester, meets UL94V-0

Potting: High thermal conductive epoxy

Heat Sink: Aluminum

UL Recognition and CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all relays shown here.

All specifications apply over the operation temperature range.

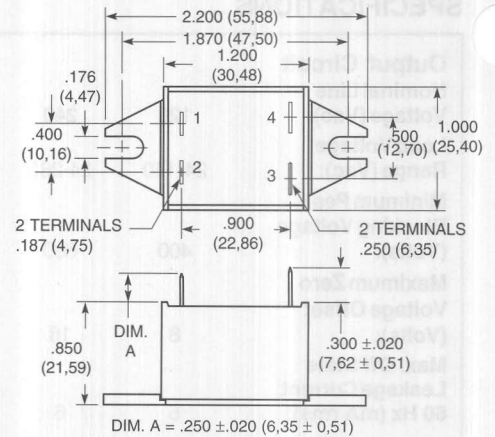
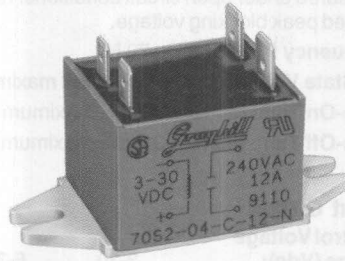
ORDERING INFORMATION

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
STYLE L			
120	6A	3-30	70S2-04-B-06-L
120	6A	6-30	70S2-05-B-06-L
240	6A	3-30	70S2-04-C-06-L
240	6A	6-30	70S2-05-C-06-L
STYLE M			
120	6A	3-30	70S2-04-B-06-M
120	6A	6-30	70S2-05-B-06-M
120	10A	3-30	70S2-04-B-10-M
120	10A	6-30	70S2-05-B-10-M
240	6A	3-30	70S2-04-C-06-M
240	6A	6-30	70S2-05-C-06-M
240	10A	3-30	70S2-04-C-10-M
240	10A	6-30	70S2-05-C-10-M

Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

DC/AC SOLID STATE RELAYS

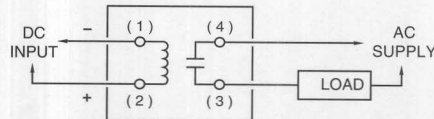
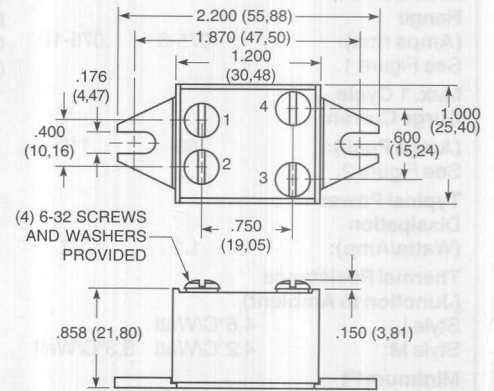
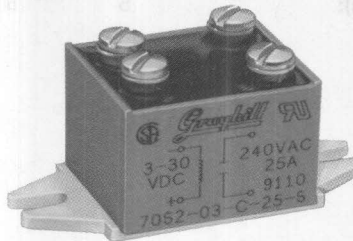
STYLE N



FEATURES

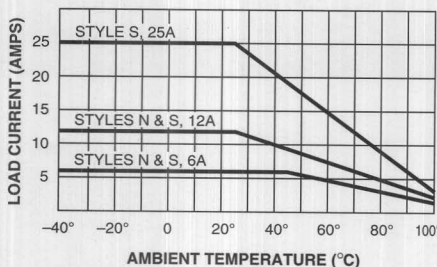
- Mini Puck® Solid State Relay
- Optically Isolated
- Panel Mount; Up to 25 Amp Loads
- Mounts on Hockey Puck Relay Centers, Yet Needs 1/2 the Space
- Screw Terminals or Push-On Tabs
- UL Recognized and CSA Certified
- Lifetime Warranty

STYLE S



DIMENSIONS ARE SHOWN IN INCHES AND (MM). ALL TOLERANCES ± 0.010 (0,25) UNLESS OTHERWISE SPECIFIED

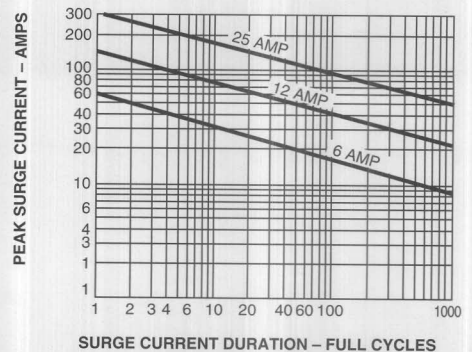
Figure 1: Maximum Continuous Current vs. Ambient Temperature



In Figure 1 the chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on the use of a 12" x 12" x 1/8" aluminum heatsink (with silicon grease) in a 2 cubic foot sealed enclosure.

In Figure 2 the information is based on a supply frequency of 60 Hertz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the relay temperature has returned to its steady state value.

Figure 2: Maximum Peak Surge Current vs. Surge Duration



SPECIFICATIONS

Output Circuit			
Nominal Line Voltage (Vac):	120	240	
Load Voltage Range (Vac):	24-140	24-280	
Minimum Peak Blocking Voltage (Volts):	400	600	
Maximum Zero Voltage Offset (Volts)			
6A & 12A Styles:	8	18	
25A Styles:	8	8	
Max. Off State Leakage Current 60 Hz (mA rms):	6	6	
Max Load Current (Amps rms):	6	12	25
Load Current Range (Amps rms):	.075-6	.1-12	.1-25
See Figure 1.			
Max. 1 Cycle Surge Current (Amps Peak):	60	150	300
See Figure 2.			
Typical Power Dissipation (Watts/Amp):	1.1	1.2	1.2
Thermal Resistance (J to C in °C/Watt):	4.2	2.4	1.75
Minimum I ² t For Fusing (Amp ² Sec at 8.3 mS):	26.5	90	500

Static dV/dT: 3000 V/microsecond typical, measured under open circuit conditions. Not to exceed peak blocking voltage.

Frequency Range: 25 to 70 Hz

On State Voltage Drop: 1.6 V peak maximum

Turn-On Time (60 Hz): 8.3 mS maximum

Turn-Off Time (60 Hz): 8.3 mS maximum

Input Circuit

Control Voltage Range (Vdc):

3-30 6-30

Control Current Range (mA)

6A & 12A Styles: 1.0-18.0 1.0-6.0

25A Styles*: 7.0-16.0

Ave. Input Impedance (Ohms)

6A & 12A Styles: 2000 6000

25A Styles*: 600

Min. Drop Out Voltage (Vdc):

1.0 1.0

Max. Reverse Control Voltage (Vdc):

5 5

*The 70S2-03-B-25-S and 70S2-03-C-25-S relays have circuits on the input which regulate the control current at higher control voltage levels. Typical control current values are shown below:

@ 3 Vdc - 7 mA

@ 5 Vdc - 10 mA

@ 24 Vdc - 13.5 mA

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): 10⁹ ohms minimum

Dielectric Strength

(Input to Output): 3000 Vrms minimum

(Input or Output to Case): 3000 Vrms min.

Capacitance (Input to Output): 6 pF typical

Vibration: 20 g's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D

Mechanical Shock: 1500 g's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F

Operating Temperature Range:

-40° to +100°C

Storage Temperature Range:

-40°C to +125°C

Weight, Style N or S: 60 grams maximum

Materials and Finishes

PC Terminals: Copper wire, Lead-Tin plated

Case: Solvent resistant thermoplastic, Polyester, meets UL94V-0

Potting: High thermal conductive epoxy

Heat Sink: Aluminum, except 25A unit which is copper, tin plated.

UL Recognition and CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all relays shown here.

All specifications apply over the operation temperature range.

ORDERING INFORMATION

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
STYLE N			
120	6A	3-30	70S2-04-B-06-N
120	6A	6-30	70S2-05-B-06-N
120	12A	3-30	70S2-04-B-12-N
120	12A	6-30	70S2-05-B-12-N
240	6A	3-30	70S2-04-C-06-N
240	6A	6-30	70S2-05-C-06-N
240	12A	3-30	70S2-04-C-12-N
240	12A	6-30	70S2-05-C-12-N

Nom. Load Vac	Max. Load, Amps	Control Voltage Vdc	Grayhill Part Number
STYLE S			
120	6A	3-30	70S2-04-B-06-S
120	6A	6-30	70S2-05-B-06-S
120	12A	3-30	70S2-04-B-12-S
120	12A	6-30	70S2-05-B-12-S
120	25A	3-30	70S2-03-B-25-S
240	6A	3-30	70S2-04-C-06-S
240	6A	6-30	70S2-05-C-06-S
240	12A	3-30	70S2-04-C-12-S
240	12A	6-30	70S2-05-C-12-S
240	25A	3-30	70S2-03-C-25-S

Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

These styles are also available in DC to DC solid state relays. See page H-13.

FEATURES

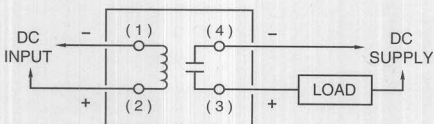
- DC Load Switching in the Popular Package Outlines and Terminations
- Optically Isolated
- PC Mount For Loads Up to 3 Amps; Require No Additional Heat Sink
- Panel Mount; Loads Up to 5 Amps
- Lifetime Warranty

Dimensions are shown in inches (and millimeters). All tolerances are ± 0.010 (0,25) unless otherwise specified.

Terminals of Style K fit standard sockets or push on tabs. Sockets are Idec part numbers SH2B-51, SH2B-62, SH2B-02 or equivalents.

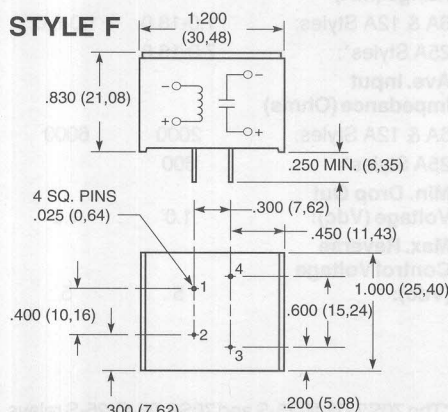
For photographic representations of product, see equivalent DC/AC relays, pages H-5 to H-12.

WIRING



CAUTION: POLARITY REVERSAL CAN PERMANENTLY DAMAGE RELAY

STYLE F



STYLE N

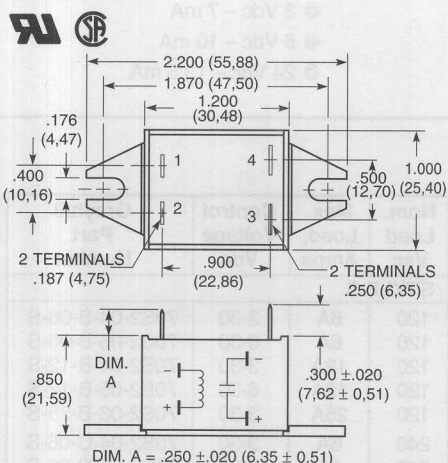
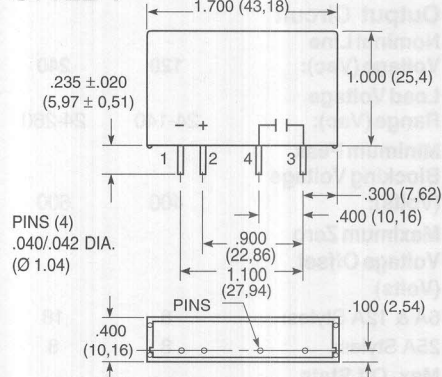


Figure 1: Maximum Continuous Current vs. Ambient Temperature

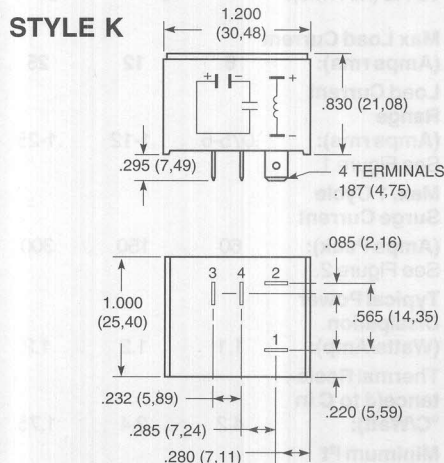
The chart indicates continuous current to limit the junction temperatures to 115°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

For 5 Amp load current, information is based on the use of a 12" x 12" x 1/8" aluminum heat sink (with silicon grease) in a 2 cubic foot sealed enclosure.

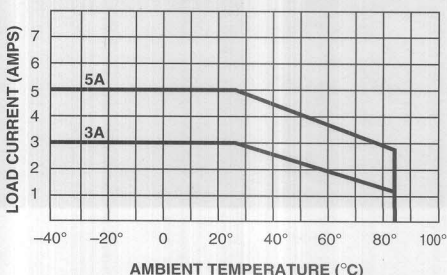
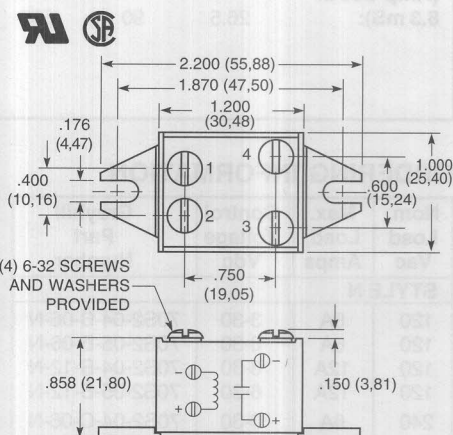
STYLE V



STYLE K



STYLE S



Styles F, K: 25°C/Watt typical

Output Circuit, Styles S & N

Load Voltage Range: 3 to 60 Vdc

Maximum Load Current: 5 Amps. See Figure 1 for derating.

Maximum Surge Current: 7 Amps for 1 second

Maximum Off State Leakage Current:
10 microamperes

Maximum On State Voltage Drop: 1.85 Vdc

Maximum Clamping Voltage: 80 Vdc

Transient Power Dissipation: 400 Watts at
1 mS, non-recurring

Typical Power Dissipation: 1.5 Watt/Amp

Thermal Resistance (Junction to Case):
8.5°C/Watt typical

Turn-On Time: 75 µsec maximum

Turn-Off Time: 500 µsec maximum

Insulation Resistance (Input to Output; Input or Output to Case): 10¹⁰ Ohms min.

Dielectric Strength (Input to Output or Case):
2500 Vrms minimum

Capacitance (Input to Output): 10 pF typical

Vibration: 20 g's peak or .06" double amplitude
10-2000 Hz per MIL-STD-202, Method 204,
Condition D

Mechanical Shock: 1500 g's 0.5 mS half-sine per
MIL-STD-202, Method 213, Condition F

Operating Temperature Range: -40° to +85°C

Storage Temperature Range: -40°C to +125°C

Weight, Style V: 25 grams maximum

Weight, Styles F, K: 35 grams maximum

Weight, Styles N, S: 47 grams maximum

70S2-01-A-05-N.

All specifications apply over the operating temperature range.

ORDERING INFORMATION

Load Voltage Vdc	Max. Load Current	Control Voltage Vdc	Grayhill Part Number
SINGLE IN-LINE PACKAGE, STYLE V			
3-60	3	3-15	70S2-01-A-03-V
3-60	3	9-30	70S2-02-A-03-V
MINI CUBE RELAY, PC MOUNT, STYLE F			
3-60	3	3-15	70S2-01-A-03-F
3-60	3	9-30	70S2-02-A-03-F
MINI CUBE RELAY, PLUG-IN STYLE K			
3-60	3	3-15	70S2-01-A-03-K
3-60	3	9-30	70S2-02-A-03-K
MINI PUCK RELAY, TAB STYLE N			
3-60	5	3-15	70S2-01-A-05-N
MINI PUCK RELAY, SCREW STYLE S			
3-60	5	3-15	70S2-01-A-05-S
3-60	5	9-30	70S2-02-A-05-S

Available from your local Grayhill Electronic and Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

These styles are also available in DC to AC solid state relays. For selection, see page H-4.

I/O MODULES

- Digital and Analog Modules on the Same Rack
- Choice of Standard, Miniature or Fusible G5 Package Styles
- Companion Racks for All Packages Solve the Mounting Problem
- Combine with Controller Boards in a Distributed Control System or Stand Alone Configuration

ENGINEERING INFORMATIONI-3

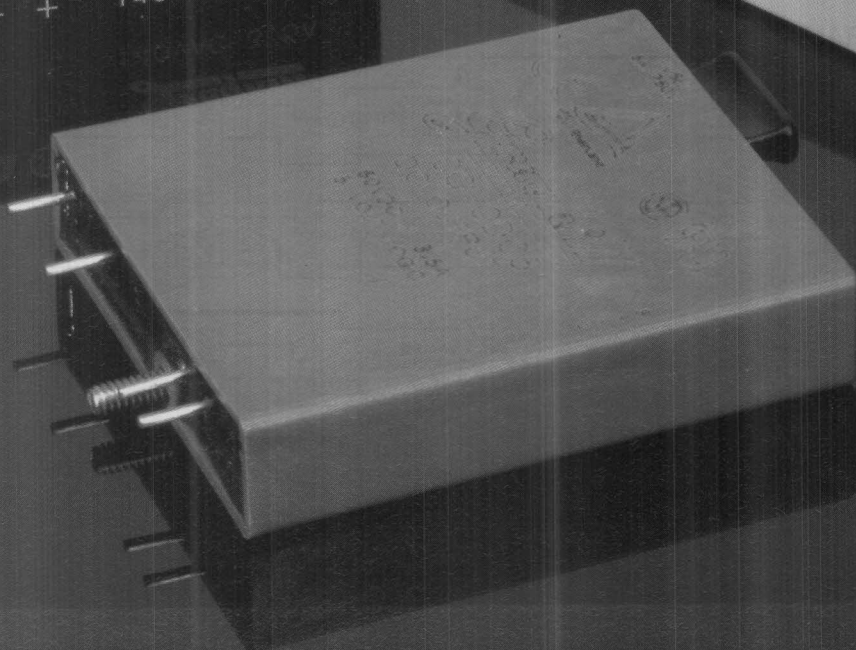
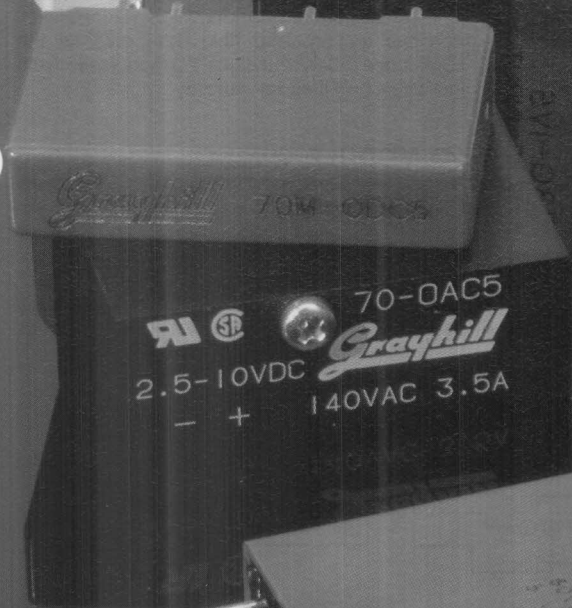
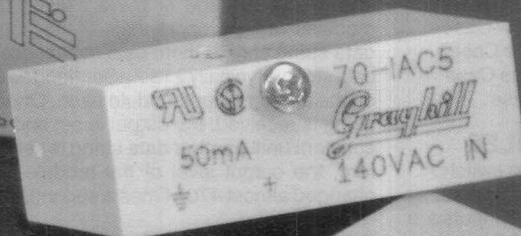
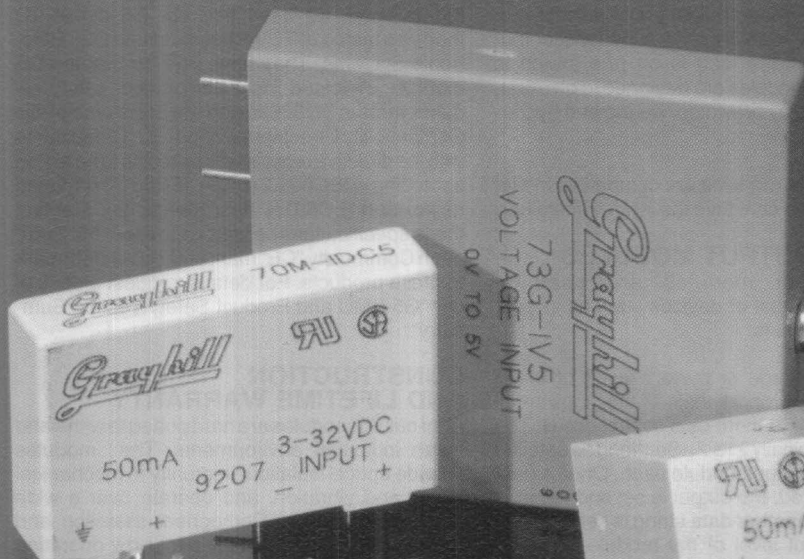
SELECTION, I/O MODULESI-6

DIGITAL I/O MODULES

AC Output Modules	I-7
DC Output Modules	I-9
Manual Override Output Modules	I-11
AC Input Modules	I-13
DC Input Modules	I-15
Contact Closure Input Modules	I-17

ANALOG I/O MODULES

Output Modules	I-18
Voltage and Current Input Modules	I-19
Current Input Modules	I-20
Thermocouple Input Modules	I-21
RTD Input Modules	I-22



The case color of these modules identify their function. The industry standard for I/O module case colors is:

Digital AC Output Module = Black Case
 Digital DC Output Module = Red Case
 Digital AC Input Module = Yellow Case
 Digital DC Input Module = White Case
 Analog Output Module = Orange Case
 Analog Input Module = Blue Case

DIGITAL OUTPUT MODULES

Digital output modules are used to switch AC and DC loads such as solenoids, motors, or lamps from logic signal levels. Their inputs are directly compatible with TTL or CMOS interface circuitry.

AC output modules have zero voltage turn-on of the load to greatly reduce generated EMI and RFI. They are highly immune to electrical transients, and have built-in RC snubber networks for increased capability with inductive loads.

DC output modules can operate DC loads over a wide voltage range and have built-in voltage spike protection.

ANALOG OUTPUT MODULES

Analog output modules are used in proportional control of devices such as valves, motors, and heaters.

The output (voltage or current level) of these modules varies proportionally to the 12 bit serial data string sent to them by a control circuit. The data string is typically 213.2 μ Sec. long as detailed on the analog output module page. Once a data string is received, the output is set and remains constant until another data string is sent. Therefore, the output level of the module could be changed almost 4700 times a second.

For more information on programming Grayhill analog output modules, request a copy of Bulletin No. 581.

ANALOG INPUT MODULES

Analog input modules are used in data gathering and proportional control applications.

Our voltage or current input modules are actually frequency converters. The input to these modules is a signal from a sensor. The output from these modules is a squarewave whose frequency varies linearly from 14.4 to 72 KHz and is proportional to the input signal. The controller must be able to measure this frequency and convert it back to a signal level.

These specifications permit us to apply the European Community "CE" mark and TÜV safety mark to these products. For details, request a copy of our "G5 EMC and Product Safety Testing Summary".

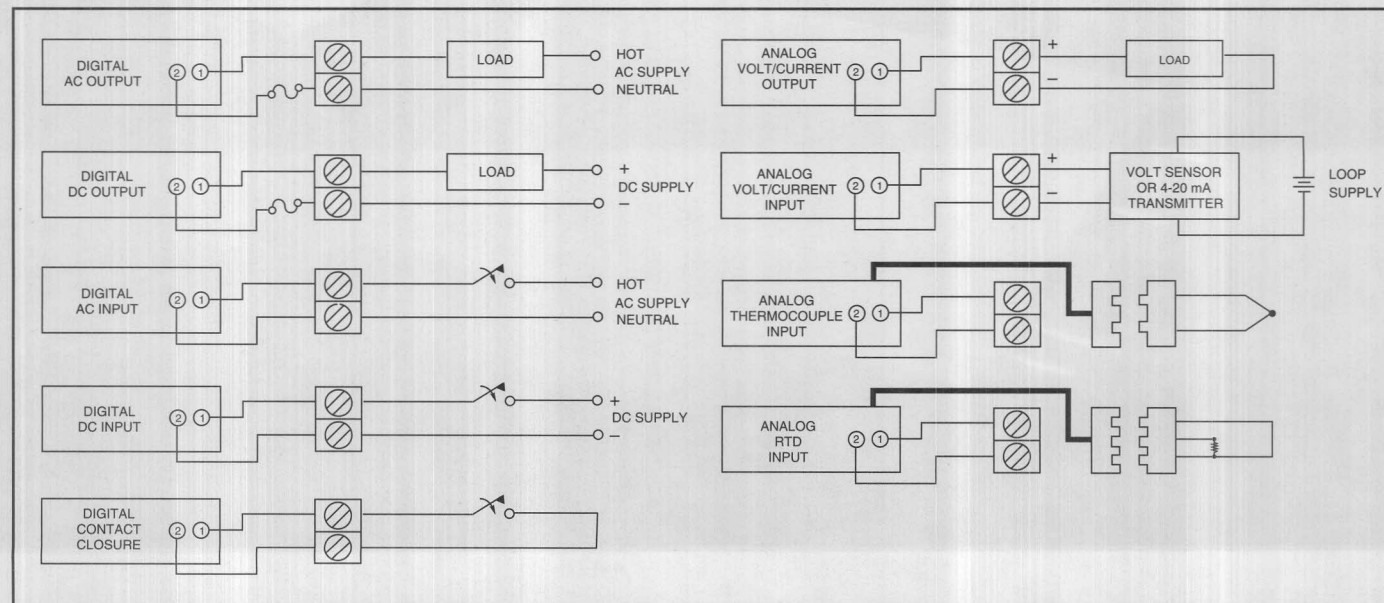
CONSTRUCTION AND LIFETIME WARRANTY

All of our I/O modules are hard potted to withstand harsh industrial environments. The modules provide optical isolation, immunity to mechanical shock and vibration, and operate over a wide temperature range. Component selection and surface mount construction allow low operating junction temperatures for long life. Superior design, rigorous testing, and field data give us the confidence to back our digital I/O modules with the industry's only lifetime warranty.

I/O MODULE WIRING

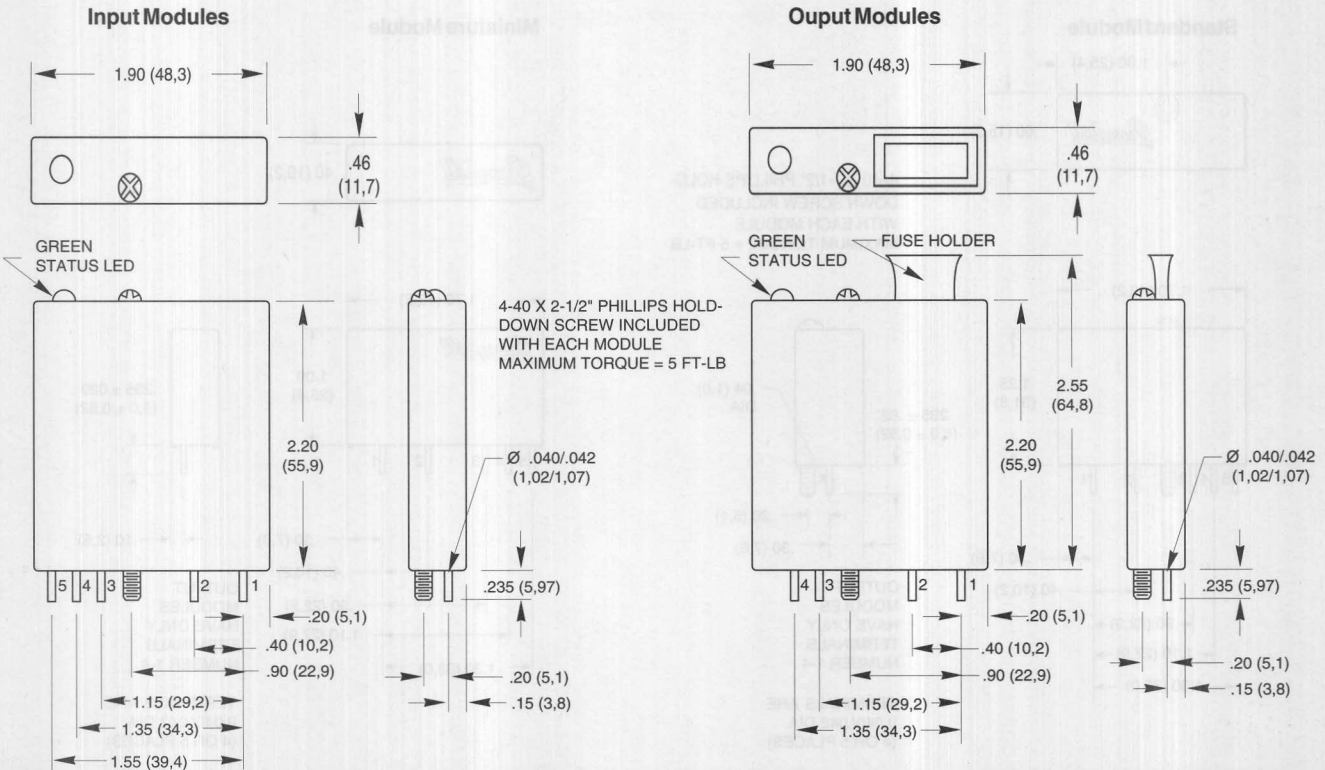
Analog and digital modules can be placed at any I/O rack location, however, to minimize the possibility of crosstalk and noise pickup it is a good practice to group similar module types together. Shown below are the wiring diagrams for each I/O module type. 14 or 16 gauge wire is typically used to wire the field devices to the I/O rack terminal block.

I/O MODULE WIRING DIAGRAM



DIMENSIONS—G5 Digital Modules

Dimensions shown in inches (and millimeters).
Tolerances are $\pm .010$ (0,25) unless indicated otherwise.

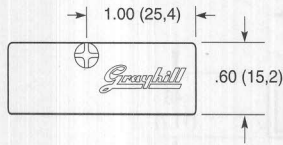


I/O MODULE ENGINEERING INFORMATION

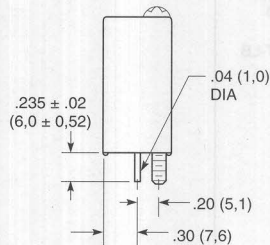
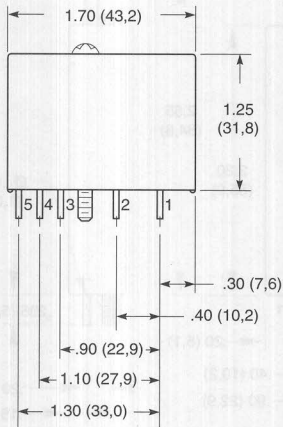
DIMENSIONS—Standard and Miniature Digital Modules

Dimensions shown in inches (and millimeters).
Tolerances are $\pm .010$ (0,25) unless indicated otherwise.

Standard Module



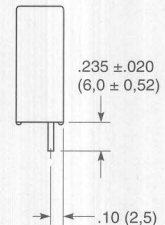
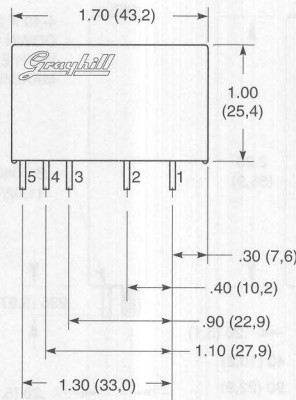
4-40 X 1-1/2" PHILLIPS HOLD-DOWN SCREW INCLUDED WITH EACH MODULE
MAXIMUM TORQUE = 5 FT-LB



OUTPUT MODULES HAVE ONLY TERMINALS NUMBER 1-4

TERMINALS ARE 0.040/.042 DIA. (4 OR 5 PLACES)

Miniature Module



OUTPUT MODULES HAVE ONLY TERMINALS NUMBER 1-4

TERMINALS ARE 0.040/.042 DIA. (4 OR 5 PLACES)

PART NUMBER EXPLANATION—I/O Modules



Module Type

- 70 = Digital Module, Standard Package
- 70G = Digital Module, G5 Package
- 70M = Digital Module, Mini Package
- 73G = Analog Module, G5 Package

Function

- OAC = Digital Output AC
- ODC = Digital Output DC
- IAC = Digital Input AC
- IDC = Digital Input DC
- OV = Analog Output, Voltage
- OI = Analog Output, Current
- IV = Analog Input, Voltage
- II = Analog Input, Current
- IT = Analog Input, Temperature

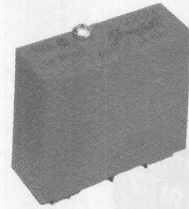
Suffix

- AC Inputs: Blank = 120 Vac
- DC Inputs: Blank = 3-32 Vdc
- G = 35-60 Vac/Vdc
- S = Dry Contacts
- A = 220 Vac
- B = Fast Switching
- D = 2.5-28 Vdc
- NP = 15-32Vac/10-32 Vdc
- K = 2.5-16 Vdc
- AC Outputs: Blank = 120 Vac
- MA = 120 Vac, Manual Override
- AMA = 240 Vac, Manual Override
- DC Outputs: Blank = 3-60 Vdc Fast
- MA = 3-60 Vdc, Manual Override
- A = 220 Vac
- A = 4-200 Vdc
- A-11 = Non-Zero Cross
- A-5 = Normally Closed
- B = 3-60 Vdc, Low Leakage
- R = Dry Contact

Logic Supply Voltage or Range

- Digital Modules: 5, 15, 24 = Logic Supply Voltage
- Analog Modules: 5 = 0-5 Vdc
- 5B = -5-5 Vdc
- 1 = 0-1 Vdc
- CJ = JTC
- CK = KTC
- CR = RTC
- CT = T TC
- 10 = 0-10 Vdc
- 10B = -10-10 Vdc
- 020 = 0 to 20 mA
- 420 = 4 to 20 mA
- 5000 = 0 to 5 A
- AC120 = 28 to 140 Vac
- AC240 = 28 to 280 Vac
- 50M = 0-50 mV
- 100M = 0-100 mV
- R100 = RTD

SIZE



Standard
Compatible Industry Size



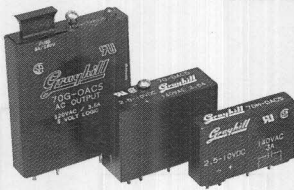
Miniature
Saves 35% Space



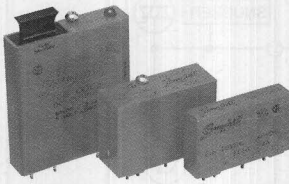
G5
Fused Outputs,
Integral LED

FUNCTION

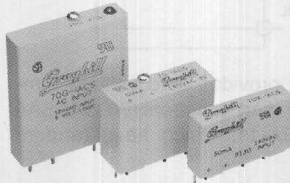
(Check Specifications for Input and Output combinations, Feature or Option availability.)



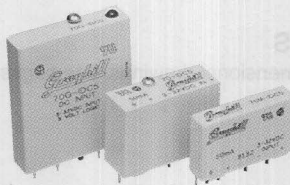
Digital AC Output	Load	Control Vcc	Unique Options	See page I-7
	120 Vac 220 Vac	5 Vdc 15 Vdc 24 Vdc	Random Turn-on Normally Closed Manual Override	



Digital DC Output	Load	Control Vcc	Unique Options	See page I-9
	60 Vdc 200 Vdc	5 Vdc 15 Vdc 24 Vdc	Dry Contacts Manual Override	



Digital AC Input	Supply Vcc	Input Voltage	Unique Options	See page I-13
	5 Vdc 15 Vdc 24 Vdc	120 Vac 220 Vac	High DC Voltage Input	



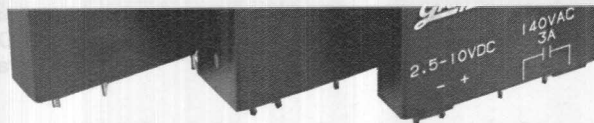
Digital DC Input	Supply Vcc	Input Voltage	Unique Options	See page I-15
	5 Vdc 15 Vdc 24 Vdc	3 to 32 Vdc	10 to 32 Vdc/ 15 to 32 Vac 8 KHz Switching 35 to 60 Vac/Vdc Contact Closure	



Analog Output	Supply Vcc	Voltage Range	Current Range	See page I-18
	5 Vdc	0 to 5 Vdc -10 to 10 Vdc	4 to 20 mA	



Analog Input	Supply Vcc	Voltage Range	Temperature	See page I-19
	5 Vdc	50 or 100 mV 1, 5, or 10 Vdc -5 to +5 Vdc -10 to +10 Vdc 28 to 140 or 280 Vac Current Range 4-20 mA 0-5 A	J Type K Type R Type T Type RTD	



70G-OAC

70-OAC

70M-OAC

Maximum Current Versus Ambient Temperature

The chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

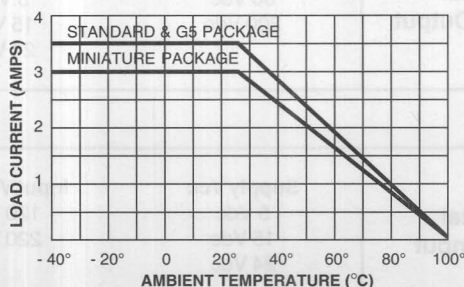


Figure 1

Maximum Peak Surge Current Versus Surge Duration

Information is based on a supply frequency of 60 Hz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the module temperature has returned to its steady state value.

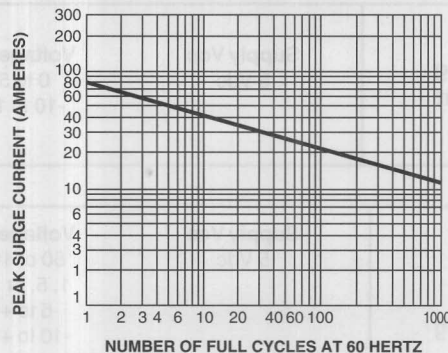
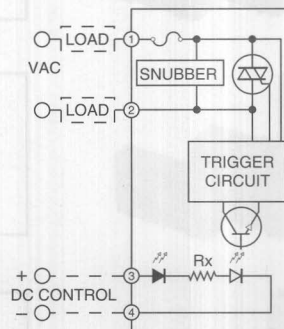


Figure 2

- G5 Modules Provide Replaceable 5 x 20 mm Glass Fuse and Built-in Status LED
- Lifetime Warranty

CIRCUITRY

Fuse and Status LED in G5 modules only.



Trigger circuit provides zero voltage turn-on except for part numbers 70-OAC5A5 and 70-OAC5A-11, which have random (fast) turn-on.

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

G5 FUSES

Fuses are 5 Amp Littlefuse part number 217005 or equivalent.

- *Part Numbers:
- 70G-OAC5
 - 70G-OAC5A
 - 70G-OAC5A-11
 - 70G-OAC15
 - 70G-OAC15A
 - 70G-OAC24
 - 70G-OAC24A

SPECIFICATIONS—All Modules

Specifications apply over operating temperature range unless noted otherwise.

Output Specifications

Load Current Range (rms): 0.03 to 3.5 Amps for part numbers beginning 70 and 70G. 0.03 to 3.0 Amps for part numbers beginning 70M. Maximum current is limited by data noted in Figure 1.

Maximum Surge Current (peak): 80 Amps at 60 Hz, 1 cycle; 25 Amps at 60Hz, 60 cycles as qualified by Figure 2.

Maximum Zero Voltage Offset: 8 V_{peak}

Static dV/dt: 3000 volts per microsecond typical, measured under open circuit conditions; not to exceed peak blocking voltage.

Turn-on Time (60 Hz): 8.3 mSec maximum (except 70-OAC5A5 which is 200 µSec and 70-OAC5A-11, 70M-OAC5A-11 and 70G-OAC5A-11 which are 100 µSec)

Turn-off Time (60 Hz): 8.3 mSec maximum

On State Voltage Drop (peak): 1.5 volts max.

Power Dissipation: 1.0 Watt/Amp typical

Load Power Factor: 0.4 minimum

Frequency Range: 25 to 70 Hz

Thermal Resistance (R_{θJA}): 25° C/Watt typical

I²t for Fusing (t = 8.3 mS): 35 A² per Sec min.

Mechanical Shock: 1500 G's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F

Storage Temperature Range:

-40°C to +125°C

Operating Temperature Range:

-40°C to +100°C

Materials and Finishes

Terminals: Copper wire, tin plated

Case: Solvent resistant thermoplastic; meets UL94V-0

Potting: High thermal conductive epoxy

UL Recognition and CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all modules shown here.

General Characteristics

Insulation Resistance (Input to Output;

Input or Output to Case): ≥ 10¹⁰ Ohms

Dielectric Strength Input to Output:

4000 Vac (rms) minimum

Input to Output Capacitance: 6 pF typical

Vibration: 20 G's peak or .06" double amplitude 10–2000 Hz per MIL-STD-202, Method 204, Condition D

SPECIFICATIONS BY PART NUMBER

Standard and Miniature Modules

Type/Function		Grayhill Part Number					
Miniature, Normally Open, Random Turn-on			70M-OAC5A-11				
Miniature, Normally Open, Zero Voltage Turn-on		70M-OAC5	70M-OAC5A	70M-OAC15	70M-OAC15A	70M-OAC24	70M-OAC24A
Standard, Normally Closed, Random Turn-on			70-OAC5A5				
Standard, Normally Open, Random Turn-on			70-OAC5A-11				70-OAC24A-11
Standard, Normally Open, Zero Voltage Turn-on		70-OAC5	70-OAC5A	70-OAC15	70-OAC15A	70-OAC24	70-OAC24A
Specifications	Units						
Nominal Line Voltage	Vac	120	240	120	240	120	240
Load Voltage Range	Vac	24-140	24-280	24-140	24-280	24-140	24-280
Minimum Peak Blocking Voltage	Volts	400	600	400	600	400	600
Maximum Off-state Leakage @ 60Hz.	mA, rms	2	4	2	4	2	4
Nominal Logic Voltage (Vcc)	Vdc	5	5	15	15	24	24
Logic Voltage Range	Vdc	2.5-10	2.5-10	10-18	10-18	15-30	15-30
Max. Logic Supply Current @ Nominal Vcc	mA	16	16	9	9	9	9
Nominal Input Resistance (Rx)	Ω	240	240	1800	1800	2700	2700
Minimum Drop Out Voltage	Vdc	1	1	1	1	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5	-5	-5	-5	-5

G5 Modules

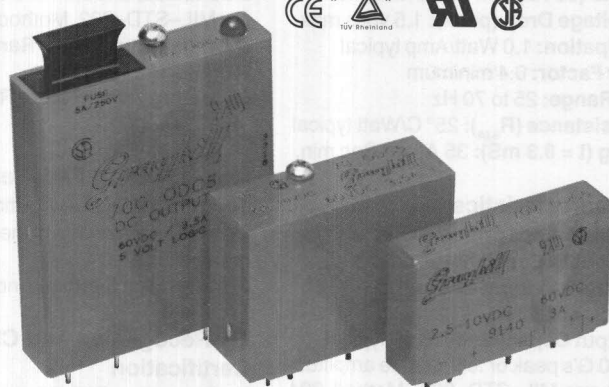
Type/Function		Grayhill Part Number					
G5 Fusible, Normally Open, Zero Voltage Turn-on		70G-OAC5	70G-OAC5A	70G-OAC15	70G-OAC15A	70G-OAC24	70G-OAC24A
G5 Fusible, Normally Open, Random Turn-on			70G-OAC5A-11				
Specifications	Units						
Nominal Line Voltage	Vac	120	240	120	240	120	240
Load Voltage Range	Vac	24-140	24-280	24-140	24-280	24-140	24-280
Minimum Peak Blocking Voltage	Volts	400	600	400	600	400	600
Maximum Off-state Leakage @ 60Hz.	mA, rms	2	4	2	4	2	4
Nominal Logic Voltage (Vcc)	Vdc	5	5	15	15	24	24
Logic Voltage Range	Vdc	4-6	4-6	8-20	8-20	18-32	18-32
Max. Logic Supply Current @ Nominal Vcc	mA	20	20	12	12	8	8
Nominal Input Resistance (Rx)	Ω	100	100	1000	1000	2700	2700
Minimum Drop Out Voltage	Vdc	1	1	1	1	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5	-5	-5	-5	-5

Available from your local Grayhill Distributors

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.



DC OUTPUT MODULE



70G-ODC

70-ODC

70M-ODC

SEE CIRCUITRY AND
DIMENSIONAL DRAWING
FOR TERMINAL ID OF
70-ODC5R AND 70G-ODC5R.

Maximum Current Versus Ambient Temperature

The chart indicates continuous current to limit the junction temperatures to 115°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

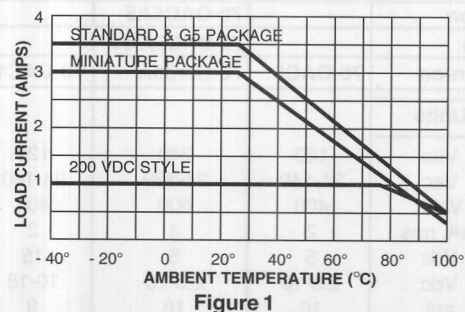


Figure 1

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

G5 FUSES

Fuses are 5 Amp Littlefuse part number 217005 or equivalent.

*Part Numbers: 70G-ODC5
70G-ODC5A
70G-ODC5B
70G-ODC15
70G-ODC15B
70G-ODC24
70G-ODC24A
70G-ODC24B

FEATURES

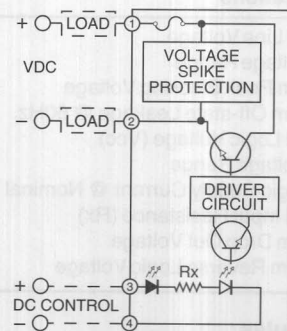
- Transient Protection: Meets the requirements of IEEE 472, "Surge Withstanding Capability Test"
- SPST, Normally Open
- UL Recognized, CSA Certified
- G5 Modules Passed IEC801.2, IEC801.3, and IEC801.4
- 4000 Vac Optical Isolation
- G5 Modules Provide Replaceable 5 x 20 mm Glass Fuse and Built-in Status LED
- Lifetime Warranty

CIRCUITRY

Two choices of switching speed vs. leakage current are offered. In applications where both AC and DC must be switched with the same module, use 70-ODC5R or 70G-ODC5R. These parts are dry contact relays in an I/O module shell. All other part numbers provide solid state switching.

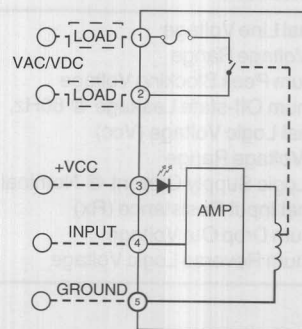
Solid State

Fuse and Status LED in G5 modules only.



Dry Contact

Fuse and Status LED in G5 modules only.



SPECIFICATIONS Specifications apply over operating temperature range unless noted otherwise.

Output Specifications		and 70G-ODC5A.	Storage Temperature Range:
Load Current Range: 0.02 to 3.5 Amps for part numbers beginning 70 and 70G; 0.02 to 3.0 Amps for 70M modules; 0.02 to 1.0 Amp for 70-ODC5A, 70M-ODC5A and 70G-ODC5A. Maximum current is limited by data noted in Figure 1.		Thermal Resistance ($R_{\theta JA}$): 20°C/Watt typical	-40°C to +125°C
Power Dissipation: 1.0 Watt/Amp typical; 1.5 Watt/Amp typ. for 70-ODC5A, 70M-ODC5A and 70G-ODC5A.		Transient Power Dissipation: 400 Watts at 1 mS non-recurring	Operating Temperature Range:
Surge Current: 5 Amps maximum for 1 second		General Characteristics	Solid State: -40°C to +100°C
On State Voltage Drop: 1.2 Volts maximum; 1.75 Volts maximum for 70-ODC5A, 70M-ODC5A and 70G-ODC5A.		Insulation Resistance (Input to Output; Input or Output to Case): $\geq 10^{10}$ Ohms	Dry Contact: -20°C to +85°C
Clamping Voltage: 80 Vdc maximum; 360 Vdc maximum for 70-ODC5A, 70M-ODC5A		Dielectric Strength Input to Output:	Materials and Finishes
		Solid State: 4000 Vac (rms) minimum	Terminals: Copper wire, tin plated
		Dry Contact: 1500 Vac (rms) minimum	Case: Solvent resistant thermoplastic; meets UL94V-0
		Input to Output Capacitance: 10 pF typical	Potting: High thermal conductive epoxy
		Vibration: 20 G's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D	UL Recognition & CSA Certification
		Mechanical Shock: 1500 G's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F	UL file number E58632 and CSA file number LR38763 apply to all modules shown here.

SPECIFICATIONS BY PART NUMBER—Solid State Modules Standard and Miniature Modules

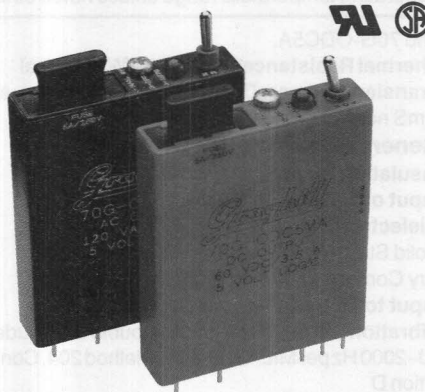
Type/Function		Grayhill Part Number						
Miniature, Normally Open		70M-ODC5	70M-ODC5A	70M-ODC5B	70M-ODC15	70M-ODC15B	70M-ODC24	70M-ODC24B
Standard, Normally Open		70-ODC5	70-ODC5A	70-ODC5B	70-ODC15	70-ODC15B	70-ODC24	70-ODC24B
Specifications	Units							
Maximum Line Voltage	Vdc	60	200	60	60	60	60	60
Load Voltage Range	Vdc	3-60	4-200	3-60	3-60	3-60	3-60	3-60
Max. Off-state Leakage @ 60 Vdc	mA	1.5	.010	.010	1.5	.010	1.5	.010
Maximum Turn-on Time	μSec	20	75	75	20	75	20	75
Maximum Turn-off Time	μSec	50	750	500	50	500	50	500
Nominal Logic Voltage (Vcc)	Vdc	5	5	5	15	15	24	24
Logic Voltage Range	Vdc	2.5-10	2.5-9	2.5-10	10-18	10-18	15-30	15-30
Max. Logic Supply Current @ Nominal Vcc	mA	14	18	14	9	9	9	9
Nominal Input Resistance (Rx)	Ω	300	220	300	1800	1800	2700	2700
Minimum Drop Out Voltage	Vdc	1	1	1	1	1	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5	-5	-5	-5	-5	-5

G5 Modules

Type/Function		Grayhill Part Number						
G5 Fusible, Normally Open		70G-ODC5	70G-ODC5A	70G-ODC5B	70G-ODC15	70G-ODC15B	70G-ODC24	70G-ODC24B
Specifications	Units							
Maximum Line Voltage	Vdc	60	200	60	60	60	60	60
Load Voltage Range	Vdc	3-60	4-200	3-60	3-60	3-60	3-60	3-60
Max. Off-state Leakage @ 60 Vdc	mA	1.5	.010	0.01	1.5	0.01	1.5	0.01
Maximum Turn-on Time	μSec	20	75	75	20	75	20	75
Maximum Turn-off Time	μSec	50	750	500	50	500	50	500
Nominal Logic Voltage (Vcc)	Vdc	5	5	5	15	15	24	24
Logic Voltage Range	Vdc	4-6	4-6	4-6	10-20	10-20	18-32	18-32
Max. Logic Supply Current @ Nominal Vcc	mA	13	13	13	9	9	9	9
Nominal Input Resistance (Rx)	Ω	150	150	150	1500	1500	2700	2700
Minimum Drop Out Voltage	Vdc	1	1	1	1	1	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5	-5	-5	-5	-5	-5

SPECIFICATIONS BY PART NUMBER—Dry Contact Modules 70-ODC5R, 70M-ODC5R and 70G-ODC5R

Output Specifications		At 48 Vdc: 100 mA-500,000 operations min.	Input Specifications
Load Voltage: 100 Vdc/120 Vac maximum		At 120 Vac: 80 mA-500,000 operations min.	Nominal Logic Voltage: 5 Vdc
Contact Rating: 10 Watts maximum		Contact Resistance: 250 mΩ maximum	Logic Voltage Range: 4.8-6.0 Vdc
Switching Current: 0.5 A dc maximum. Inductive loads require diode suppression.		Turn-on Time: 1.0 mSec maximum (including bounce)	Max Logic Supply Current at Nominal Voltage: 10 mA
Carry Current: 1.0 A maximum. Inductive loads require diode suppression.		Turn-off Time: 1.0 mSec maximum (including bounce)	Input Resistance: 500 Ω
Life Expectancy:		Off-State Leakage Current: 2 μA maximum at 60 Hz	Pick Up Voltage: 0.8 Vdc minimum
At 10 Vdc: 10 mA-200,000,000 operations min.			Drop Out Voltage: 2.5 Vdc minimum
			Reverse Logic Voltage: 5 Vdc maximum



FEATURES

- Integral Three Position Manual On/Manual Off and Automatic Control Toggle Switch
- Transient Protection: Meets the requirements of IEEE 472, "Surge Withstanding Capability Test"
- UL Recognized, CSA Certified
- 4000 Vac Optical Isolation
- G5 Modules Provide Replaceable 5 x 20 mm Glass Fuse and Built-in Status LED

Maximum Current Versus Ambient Temperature

The chart indicates continuous current to limit the junction temperatures to 100°C. Information is based on steady state heat transfer in a 2 cubic foot sealed enclosure.

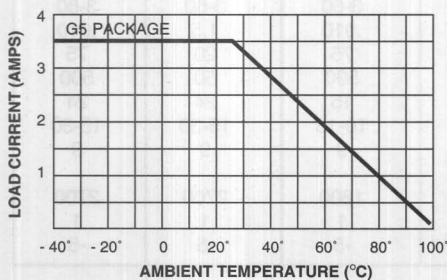
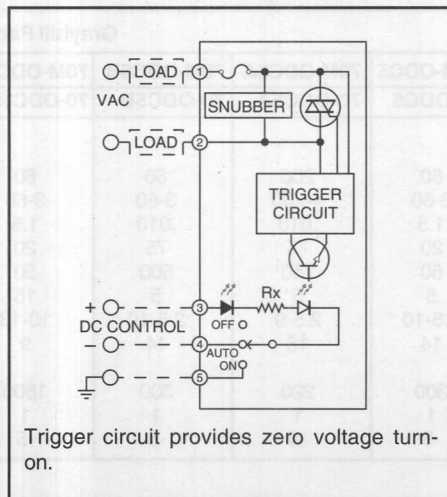
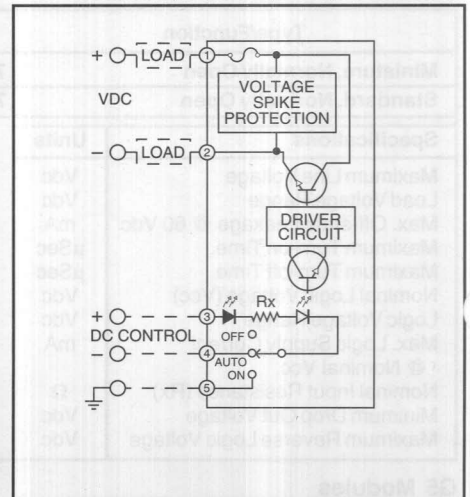


Figure 1

CIRCUITRY (AC Outputs)



CIRCUITRY (DC Outputs)



Maximum Peak Surge Current Versus Surge Duration (AC Outputs)

Information is based on a supply frequency of 60 Hz sinusoidal and a resistive or inductive load. Application of maximum surge current may not be repeated until the module temperature has returned to its steady state value.

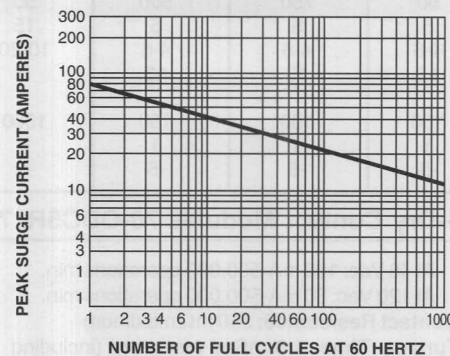


Figure 2

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

G5 FUSES

Fuses are 5 Amp Littlefuse part number 217005 or equivalent.

SPECIFICATIONS—All Modules

Specifications apply over operating temperature range unless noted otherwise.

Output Specifications

Load Current Range (rms): 0.03 to 3.5 Amps
Maximum current is limited by data noted in Figure 1.

Maximum Surge Current (peak): 80 Amps at 60 Hz, 1 cycle; 25 Amps at 60Hz, 60 cycles as qualified by Figure 2 for AC outputs. 5 Amp maximum for 1 second for DC outputs.

Turn-on Time (60 Hz): 8.3 mSec maximum for AC outputs. 20 μ Sec maximum for DC outputs.

Turn-off Time (60 Hz): 8.3 mSec maximum for AC outputs. 50 μ Sec maximum for DC outputs.

On State Voltage Drop (peak): 1.5 volts max.

Power Dissipation: 1.0 Watt/Amp typical

Thermal Resistance ($R_{\theta JA}$): 25° C/Watt typical

General Characteristics

Insulation Resistance (Input to Output;

Input or Output to Case): $\geq 10^{10}$ Ohms

Dielectric Strength Input to Output:

4000 Vac (rms) minimum

Input to Output Capacitance: 6 pF typical

Vibration: 20 G's peak or .06" double amplitude 10–2000 Hz per MIL–STD–202, Method 204, Condition D

Mechanical Shock: 1500 G's 0.5 mS half-sine per MIL–STD–202, Method 213, Condition F

Storage Temperature Range:

-40°C to +125°C

Operating Temperature Range:

-40°C to +100°C

Materials and Finishes

Terminals: Copper wire, tin plated

Case: Solvent resistant thermoplastic; meets UL94V–0

Potting: High thermal conductive epoxy

UL Recognition and CSA

Certification

UL file number E58632 and CSA file number LR38763 apply to all modules shown here.

SPECIFICATIONS BY PART NUMBER

AC Outputs

Type/Function		Grayhill Part Number			
G5, Zero Voltage Turn On, Manual Override		70G-OAC5MA	70G-OAC5AMA	70G-OAC24MA	70G-OAC24AMA
Specifications	Units				
Nominal Line Voltage	Vac	120	240	120	240
Load Voltage Range	Vac	24-140	24-280	24-140	24-280
Minimum Peak Blocking Voltage	Volts	400	600	400	600
Maximum Off-state Leakage @ 60Hz.	mA, rms	2	4	2	4
Nominal Logic Voltage (V_{cc})	Vdc	5	5	24	24
Logic Voltage Range	Vdc	4-6	4-6	18-32	18-32
Max. Logic Supply Current @ Nominal V_{cc}	mA	20	20	8	8
Nominal Input Resistance (R_x)	Ω	100	100	2700	2700
Minimum Drop Out Voltage	Vdc	1	1	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5	-5	-5
Maximum Zero Voltage Offset	(Vpeak)	8	8	8	8
Frequency Range	(Hz)	25-70	25-70	25-70	25-70

DC Outputs

Type/Function		Grayhill Part Number	
G5 Manual Override		70G-ODC5MA	70G-ODC24MA
Specifications	Units		
Maximum Line Voltage	Vdc	60	60
Load Voltage Range	Vdc	3-60	3-60
Max. Off-state Leakage @ 60 Vdc	mA	1.5	1.5
Maximum Turn-on Time	μ Sec	20	20
Maximum Turn-off Time	μ Sec	50	50
Nominal Logic Voltage (V_{cc})	Vdc	5	24
Logic Voltage Range	Vdc	4-6	18-32
Max. Logic Supply Current @ Nominal V_{cc}	mA	13	9
Nominal Input Resistance (R_x)	Ω	150	2700
Minimum Drop Out Voltage	Vdc	1	1
Maximum Reverse Logic Voltage	Vdc	-5	-5
Maximum Clamping Voltage	Vdc	80	80

Available from your local Grayhill Distributors

For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.



70G-IAC

70-IAC

70M-IAC



FEATURES

- Transient Protection: Meets the requirements of IEEE 472, "Surge Withstanding Capability Test"
- G5 Modules Passed IEC801.2, IEC801.3, and IEC801.4
- UL Recognized, CSA Certified
- 4000 Vac Optical Isolation
- G5 Module has Built-in Status LED
- Lifetime Warranty

Typical Logic Supply Current Versus Logic Supply Voltage

For Figures 1 and 2, all values were measured at 25°C. The logic supply voltage continuum represents the voltage range for each of the three nominal voltages (5, 15, and 24 Vdc).

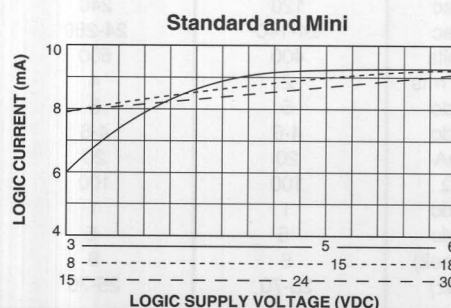


Figure 1

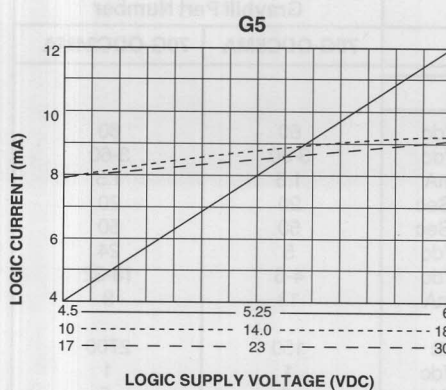
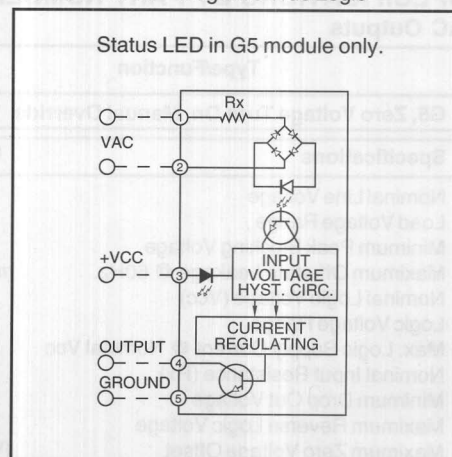


Figure 2

CIRCUITRY Negative True Logic



DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

- *Part Numbers: 70G-IAC5
70G-IAC5A
70G-IAC15
70G-IAC15A
70G-IAC24
70G-IAC24A

SPECIFICATIONS—All Modules

Specifications apply over operating temperature range unless noted otherwise.

Output Specifications

Output Current Range: 1-50 mA
Breakdown Voltage: 50 Vdc minimum
Off-State Leakage Current: 1 μ A maximum
Turn-on Time: 20 mSec maximum
Turn-off Time: 20 mSec maximum
On State Voltage Drop: 0.45 Vdc at 50 mA maximum

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): $\geq 10^{10}$ Ohms
Dielectric Strength Input to Output: 4000 Vac (rms) minimum
Input to Output Capacitance: 6 pF typical
Vibration: 20 G's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D
Mechanical Shock: 1500 G's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F
Storage Temperature Range: -40°C to +125°C
Operating Temperature Range: -40°C to +100°C

Materials and Finishes

Terminals: Copper wire, tin plated
Case: Solvent resistant thermoplastic; meets UL94V-0
Potting: High thermal conductive epoxy

UL Recognition and CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all modules shown here.

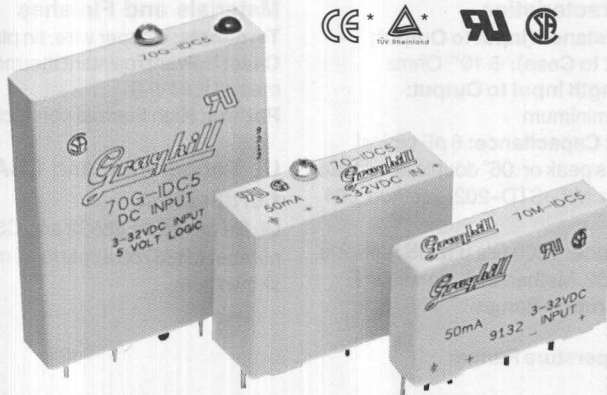
SPECIFICATIONS BY PART NUMBER

Type/Function		Grayhill Part Number					
G5, Status LED		70G-IAC5	70G-IAC5A	70G-IAC15	70G-IAC15A	70G-IAC24	70G-IAC24A
Miniature		70M-IAC5	70M-IAC5A	70M-IAC15	70M-IAC15A	70M-IAC24	70M-IAC24A
Standard		70-IAC5	70-IAC5A	70-IAC15	70-IAC15A	70-IAC24	70-IAC24A
Specifications	Units						
Nominal Input Voltage	Vac	120	240	120	240	120	240
Input Voltage Range*	Vac/Vdc	90-140	180-280	90-140	180-280	90-140	180-280
Input Current at Maximum Input Voltage	mA, rms	8	6	8	6	8	6
Nominal Input Resistance (Rx)	Ω	22K	60K	22K	60K	22K	60K
Maximum Pick Up Voltage (Output Low)	Vac	90	180	90	180	90	180
Minimum Drop Out Voltage (Output High)	Vac	25	50	25	50	25	50
Nominal Logic Voltage (Vcc)	Vdc	5	5	15	15	24	24
Logic Voltage Range: Standard and Mini	Vdc	3-6	3-6	8-18	8-18	15-30	15-30
G5	Vdc	4.5-6	4.5-6	10-18	10-18	17-30	17-30
Max. Logic Supply Current @ Nominal Vcc (See Figure 1 or 2)	mA	10	10	10	10	10	10

* For input voltages in the range of 15-32 Vac, or 35-60 Vac, see DC input Modules with the NP or G suffix.

Available from your local Grayhill Distributors
 For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

DC INPUT MODULE



70G-IDC

70-IDC

70M-IDC

Typical Logic Supply Current Versus Logic Supply Voltage

For Figures 1 and 2, all values were measured at 25°C. The logic supply voltage continuum represents the voltage range for each of the three nominal voltages (5, 15, and 24 Vdc).

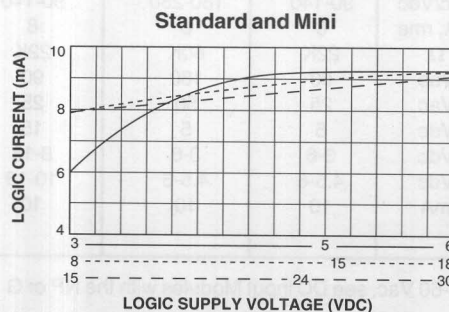


Figure 1

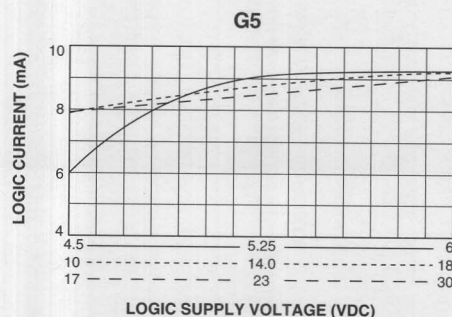


Figure 2

DIMENSIONS

For complete dimensional drawings, see the I/O Engineering Information pages.

*Part Numbers: 70G-IDC5	70G-IDC15
70G-IDC5B	70G-IDC15NP
70G-IDC5G	70G-IDC24
70G-IDC5NP	70G-IDC24NP
70G-IDC5S	

FEATURES

- Transient Protection: Meets the requirements of IEEE 472, "Surge Withstanding Capability Test"***
- Fast Switching Polarized Input Types
- Non-Polarized Types Provide Inputs For AC or DC
- UL Recognized, CSA Certified
- G5 Modules Passed IEC801.2, IEC801.3, and IEC801.4
- 4000 Vac Optical Isolation
- G5 Module has Built-in Status LED
- Lifetime Warranty

***All modules except 70-IDC5B, 70G-IDC5B, and 70G-IDC5D meet IEEE 472, "Surge Withstanding Capability Test"

CIRCUITRY Negative True Logic

Modules have either a polarized (Figure 3) or non-polarized (Figure 4) input. When replacing modules from another manufacturer, check the wiring diagrams below against the application circuit. In many instances, polarized modules can be used to replace non-polarized modules if the polarity matches the application, thus providing faster turn-on.

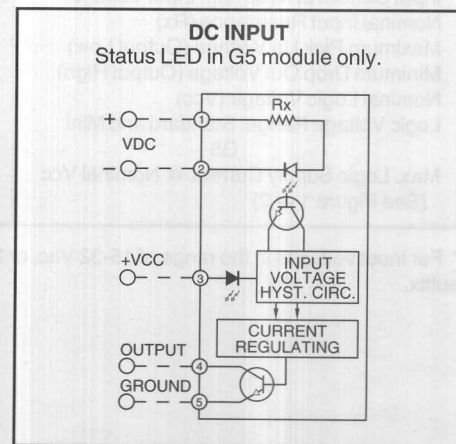


Figure 3: With Polarized Input

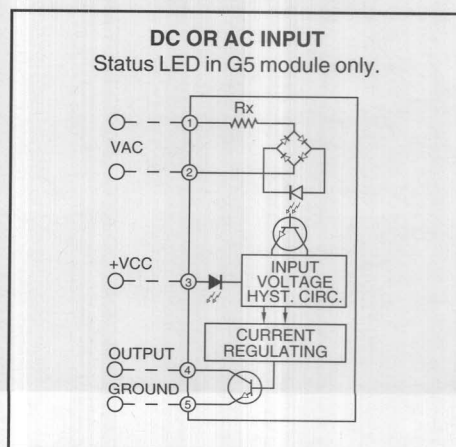


Figure 4: With Non-Polarized (NP) Input

SPECIFICATIONS—All Modules

Specifications apply over operating temperature range unless noted otherwise.

Output Specifications

Output Current Range: 1-50 mA
Breakdown Voltage: 50 Vdc minimum
Off State Leakage Current: 1 μ A maximum
On State Voltage Drop: 0.45 Vdc at 50 mA maximum
Storage Temperature Range:
 -40°C to +125°C
Operating Temperature Range:
 -40°C to +100°C

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): $\geq 10^{10}$ Ohms
Dielectric Strength Input to Output:
 4000 Vac (rms) minimum
Input to Output Capacitance: 6 pF typical
Vibration: 20 G's peak or .06" double amplitude
 10-2000 Hz per MIL-STD-202, Method 204, Condition D
Mechanical Shock: 1500 G's 0.5 mS half-sine
 per MIL-STD-202, Method 213, Condition F

Materials and Finishes

Terminals: Copper wire, tin plated
Case: Solvent resistant thermoplastic; meets UL94V-0
Potting: High thermal conductive epoxy

UL Recognition & CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all modules shown here, except 70-IDC5B and 70M-IDC5NP.

SPECIFICATIONS—By Part Number (DC Input Only)

Type/Function		Grayhill Part Number					
G5, Polarized		70G-IDC5	70G-IDC5B	70G-IDC5D	70G-IDC5K	70G-IDC15	70G-IDC24
Miniature, Polarized		70M-IDC5				70M-IDC15	70M-IDC24
Standard, Polarized		70-IDC5	70-IDC5B			70-IDC15	70-IDC24
Specifications	Units						
Maximum Input Voltage	Vdc	32	32	28	16	32	32
Input Voltage Range*	Vdc	3-32	3-32	2.5-28	2.5-16	3-32	3-32
Input Current at Max. Input Voltage	mA	18	18	23	30	18	18
Maximum Turn-on Time	mSec	0.20	0.050	0.050	0.025	0.20	0.20
Maximum Turn-off Time	mSec	0.40	0.075	0.075	0.025	0.40	0.40
Nominal Input Resistance (Rx)	Ω	1.8K	1.8K	1.2K	500	1.8K	1.8K
Max. Pick Up Voltage (Output Low)	Vdc	3	3	2.5	2.5	3	3
Min. Drop Out Voltage (Output High)	Vdc	1	1	1	1	1	1
Nominal Logic Voltage (Vcc)	Vdc	5	5	5	5	15	24
Logic Voltage Range: Std & Mini	Vdc	3-6	3-6			8-18	15-30
G5	Vdc	4.5-6	4.5-6	4.5-6	4.5-6	10-18	17-30
Max. Logic Supply Current @ Nominal Vcc (See Figure 1 or 2)	mA	10	18	10	18	10	10

SPECIFICATIONS—By Part Number (AC or DC Input)

Type/Function		Grayhill Part Number			
G5, Non-Polarized		70G-IDC5G	70G-IDC5NP	70G-IDC15NP	70G-IDC24NP
Miniature, Non-Polarized		70M-IDC5G	70M-IDC5NP		
Standard, Non-Polarized		70-IDC5G	70-IDC-5NP	70-IDC15NP	70-IDC24NP
Specifications	Units				
Maximum Input Voltage	Vac/Vdc	60	32	28	32
Input Voltage Range*	Vac/Vdc	35-60	15-32/10-32	15-32/10-32	15-32/10-32
Input Current at Max. Input Voltage	mA	6	25	25	25
Maximum Turn-on Time	mSec	10	5	5	5
Maximum Turn-off Time	mSec	10	5	5	5
Nominal Input Resistance (Rx)	Ω	10K	1.8K	1.8K	1.8K
Max. Pick Up Voltage (Output Low)	Vac/Vdc	35	15/10	15/10	15/10
Min. Drop Out Voltage (Output High)	Vac/Vdc	9	3	3	3
Nominal Logic Voltage (Vcc)	Vdc	5	5	15	24
Logic Voltage Range: Std & Mini	Vdc	3-6	3-6	8-18	15-30
G5	Vdc	4.5-6	4.5-6	10-18	17-30
Max. Logic Supply Current @ Nominal Vcc (See Figure 1 or 2)	mA	10	10	10	10

* For input voltages in the range of 90 to 140 Vdc, use AC input modules 70-IAC5, 70M-IAC5 or 70G-IAC5. For input voltages in the range of 180 to 280 Vdc, use AC input modules 70-IAC5A, 70M-IAC5A or 70G-IAC5A.

Available from your local Grayhill Distributors
 For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

CONTACT CLOSURE DC INPUT MODULE

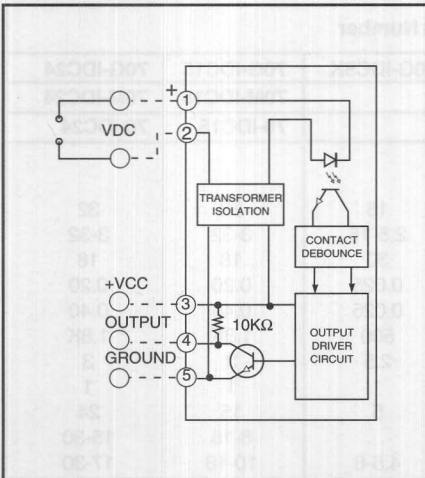
FEATURES

- Wire Dry Contact Sensors Directly to Module, Eliminate External Power Supply
- 2500 Vac Isolation
- Built-In Status LED
- UL Recognized, CSA Certified



CIRCUITRY

Negative True Logic



SPECIFICATIONS—All Modules

Specifications apply over operating temperature range unless noted otherwise.

Output Specifications

Output Current Range: 1-50 mA
Breakdown Voltage: 50 Vdc minimum
Off State Leakage Current: 1 μ A maximum
On State Voltage Drop: 0.45 Vdc at 50 mA maximum

General Characteristics

Insulation Resistance (Input to Output; Input or Output to Case): $\geq 10^{10}$ Ohms
Dielectric Strength Input to Output: 2500 Vac (rms) minimum
Input to Output Capacitance: 6 pF typical
Vibration: 20 G's peak or .06" double amplitude 10-2000 Hz per MIL-STD-202, Method 204, Condition D

Mechanical Shock: 1500 G's 0.5 mS half-sine per MIL-STD-202, Method 213, Condition F
Storage Temperature Range: -40°C to 125°C
Operating Temperature Range: 0°C to +60°C

Materials and Finishes

Terminals: Copper wire, tin plated
Case: Solvent resistant thermoplastic; meets UL94V-0
Potting: High thermal conductive epoxy

UL Recognition & CSA Certification

UL file number E58632 and CSA file number LR38763 apply to all modules shown here.

SPECIFICATIONS—By Part Number

Type/Function		Grayhill Part Number	
G5, Dry Contact		70G-IDC5S	70G-IDC24S
Specifications	Units		
Maximum Dry Contact Voltage Rating	Vdc	25	25
Minimum Dry Contact Current Rating	mA	5	5
Maximum Turn-on Time	mSec	3.0	3.0
Maximum Turn-off Time	mSec	3.0	3.0
Contact Resistance (Output Low)	Ω	$\leq 1.25K$	$\leq 1.25K$
Contact Resistance (Output High)	Ω	$\leq 25K$	$\leq 25K$
Nominal Logic Voltage (Vcc)	Vdc	5	24
Logic Voltage Range: G5	Vdc	4.5-6	15-30
Max. Logic Supply Current @ Nominal Vcc	mA	41	41

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

FEATURES

- Voltage Output Modules for 0-5V, 0-10V, and -10 to +10 Vdc
- Current Output Module for 0-20mA
- Standard Package and Pin-out
- Single 5V Power Supply
- 12 Bit Resolution
- Optical Isolation from Input to Output
- Intermix With G5 Digital Modules on the Same Rack
- Meets the Requirements of IEEE 472

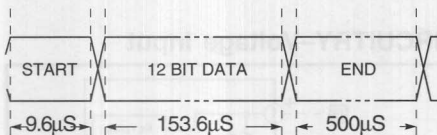
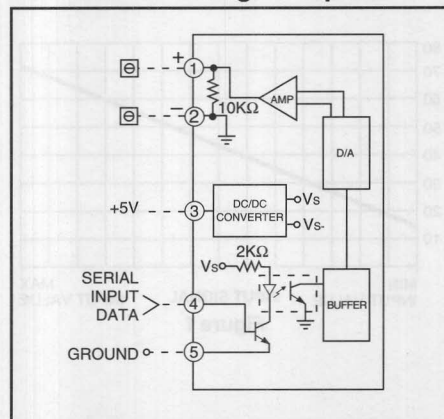


Figure 1

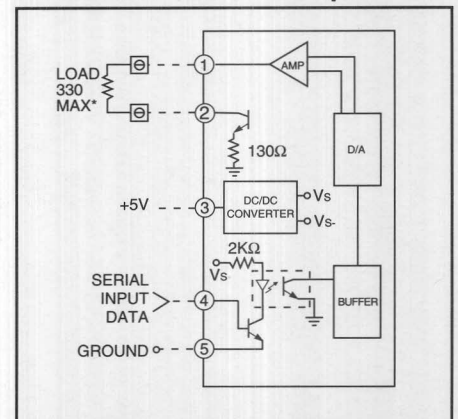
Start Pulse: High for 6.4 μ S Min. then low for 3.2 μ S
 Data Packet: Each bit is 12.8 μ S long. High for first 3.2 μ S of the bit. Middle 6.4 μ S determines the value of the data bit (High = 1, Low = 0). Low for last 3.2 μ S of the bit.
 Stop Pulse: Low for 500 μ S Min.
 Times shown are $\pm 10\%$, except Mins.

SERIAL DATA FORMAT**

CIRCUITRY—Voltage Output



CIRCUITRY—Current Output



SPECIFICATIONS

Voltage Output Modules

Input Data: 12 bit serial data as shown in Figure 1

Input Voltage High: 2.0 Vdc min.

Input Voltage Low: 0 to 1 Vdc

Input Current: 1.4 mA @ 2 Vdc, 4.3 mA @ 5.0 Vdc

Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc

Supply Current at 5 Vdc: 140 mA max.

Output Current (Sourcing):

73G-OV5 - 20 mA max. at 5 Vdc

73G-OV5B - 10 mA max. at 5 Vdc

73G-OV10 - 10 mA max. at 10 Vdc

73G-OV10B - 10 mA max. at 10 Vdc

Accuracy, Full Scale at 25°C: $\pm 0.3\%$

Offset Drift: ± 45 PPM/°C

Gain Drift: ± 150 PPM/°C

Response Time: Output signal level is

adjusted within 500 μ S of the beginning of the stop pulse.

Current Output Module

Input Data: 12 bit serial data as shown in Figure 1

Input Voltage High: 2.0 Vdc min.

Input Voltage Low: 0 to 1 Vdc

Input Current: 1.4 mA @ 2 Vdc, 4.3 mA @ 5.0 Vdc

Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc

Supply Current at 5 Vdc: 240 mA max.

Output Current (Sourcing): 20 mA max.

(330 Ohm max. loop resistance). External loop supply can increase maximum loop resistance rating.

Accuracy, Full Scale at 25°C: $\pm 0.3\%$

Offset Drift: ± 45 PPM/°C

Gain Drift: ± 150 PPM/°C

Response Time: Output signal level is adjusted within 500 μ S of the beginning of the stop pulse.

Additional Characteristics

Isolation (Input to Output): 2500 Vrms

Isolation (Output to Power Supply):

2500 Vrms

Operating Temperature Range: 0° to 60°C

Storage Temperature Range: -25° to 85°C

Power Up Status: Output signal at minimum value.

Short Circuit Protection: Output signal can be shorted to ground without damaging the module.

**Additional Information

Request a copy of Bulletin No. 581, Programming 73G Analog Output Modules.

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

ORDERING INFORMATION

Available from your local Grayhill Distributor

For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

Output Type	Range	Resolution (1 Bit Change)	Part Number
Voltage	0 to 5 Vdc	1.22 mV	73G-OV5
Voltage	-5 to 5 Vdc	2.44 mV	73G-OV5B
Voltage	0 to 10 Vdc	2.44 mV	73G-OV10
Voltage	-10 to 10 Vdc	4.88 mV	73G-OV10B
Current	4 to 20 mA	3.9 μ A	73G-OI420
Current	0 to 20 mA	4.9 μ A	73G-OI020

VOLTAGE INPUT MODULES

FEATURES

- Voltage Input Modules for Ranges from 0-50mV to ± 10 Vdc, 120/220 Vac
- Standard Package and Pin-out
- Single 5V Power Supply
- 12 Bit Resolution
- Optical Isolation from Input to Output
- Intermix With G5 Digital Modules on the Same Rack
- Meets the Requirements of IEEE 472

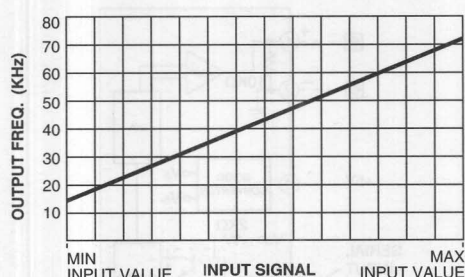
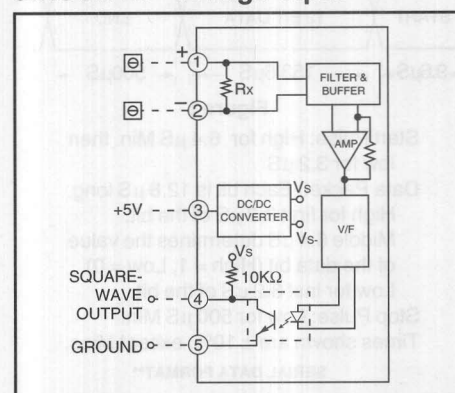


Figure 1

CIRCUITRY—Voltage Input



SPECIFICATIONS

Voltage Input Modules

Input Resistance (R_x): 1M ohms

Common Mode Reject: > 100dB

Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc

Supply Current at 5 Vdc: 150 mA max.

Output Frequency: 14.4 to 72.0 KHz

squarewave as shown in Figure 1

Squarewave Amplitude: 0 to V_{cc} -10% min.

Squarewave Duty Cycle: 40% to 60%

Accuracy, Full Scale at 25°C:

$\pm 0.1\%$ (DC versions)

$\pm 0.3\%$ (AC versions)

Offset Drift: ± 50 PPM/°C (DC versions)

± 150 PPM/°C (AC versions)

Gain Drift: ± 55 PPM/°C (DC versions)

± 150 PPM/°C (AC versions)

Response Time: Output frequency changes to within 1% of final reading within 2.5 mS.

Additional Characteristics

Isolation (Input to Output): 2500 Vrms

Isolation (Input to Power Supply): 2500 Vrms

Operating Temperature Range: 0° to 60°C

Storage Temperature Range: -25° to 85°C

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

Available from your local Grayhill Distributor

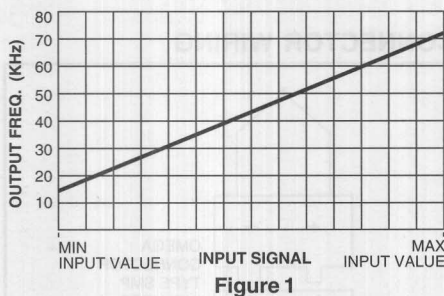
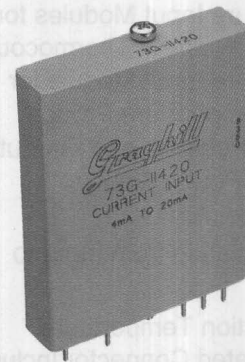
For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

ORDERING INFORMATION

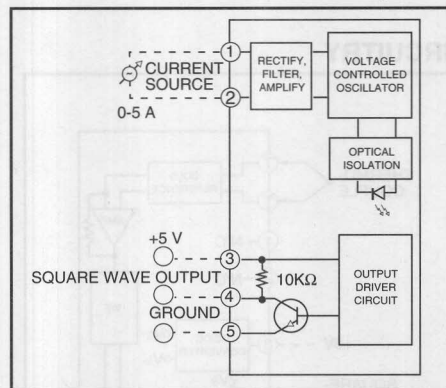
Input Type	Range	Resolution	Part Number
Voltage	0 to 50 mV	12.2 μ V	73G-IV50M
Voltage	0 to 100 mV	24.4 μ V	73G-IV100M
Voltage	0 to 1 Vdc	244.1 μ V	73G-IV1
Voltage	0 to 5 Vdc	1.22 mV	73G-IV5
Voltage	0 to 10 Vdc	2.44 mV	73G-IV10
Voltage	-5 to 5 Vdc	2.44 mV	73G-IV5B
Voltage	-10 to 10 Vdc	4.88 mV	73G-IV10B
Voltage	28 to 140 Vac	27.34 mV	73G-IVAC120
Voltage	28 to 280 Vac	65.52 mV	73G-IVAC240

FEATURES

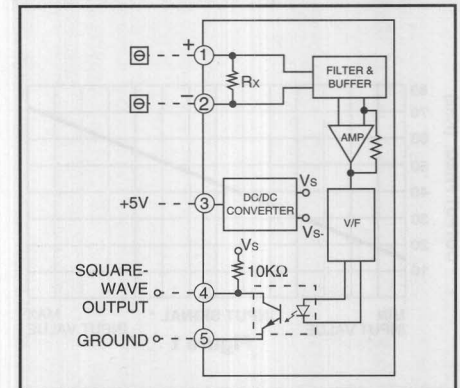
- Current Input Module for 0-20 mA, 4-20mA or 0-5 A
- Standard Package and Pin-out
- Single 5V Power Supply
- 12 Bit Resolution
- Optical Isolation from Input to Output
- Intermix With G5 Digital Modules on the Same Rack
- Meets the Requirements of IEEE 472



CIRCUITRY- 0-5 A Current Input



CIRCUITRY- 4-20 mA Current Input



SPECIFICATIONS

0-20 or 4-20 mA Input Modules

Input Resistance (R_x): 133 ohms \pm 1%
Common Mode Reject: > 100dB
Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc
Supply Current at 5 Vdc:
 150 mA (0-20 mA version)
 120 mA (4-20 mA version)

0-5 A Input Modules

Input Resistance (R_x): 0.02 Ω typical
Common Mode Reject: > 90 dB
Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc
Supply Current at 5 Vdc: 160 mA max.

Output Frequency: 14.4 to 72.0 KHz squarewave as shown in Figure 1
Squarewave Amplitude: 0 to V_{cc} -10% min.
Squarewave Duty Cycle: 35% to 60%
Accuracy, Full Scale at 25°C:
 \pm 0.1% (0-20 and 4-20 mA version)
 \pm 0.3% (0-5 A version)

Offset Drift:
 \pm 50 PPM/°C (0-20 and 4-20 mA version)
 \pm 150 PPM/°C (0-5 A version)

Gain Drift:
 \pm 55 PPM/°C (0-20 and 4-20 mA version)
 \pm 150 PPM/°C (0-5 A version)

Response Time: Output frequency changes to within 1% of final reading within 2.5 mS.

Additional Characteristics

Isolation (Input to Output): 2500 Vrms

Isolation (Input to Power Supply): 2500 Vrms

Operating Temperature Range: 0° to 60°C

Storage Temperature Range: -25° to 85°C

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

ORDERING INFORMATION

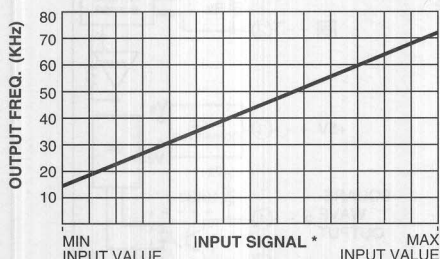
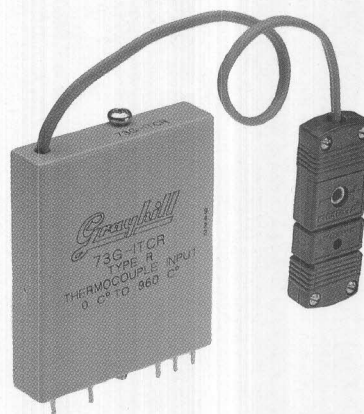
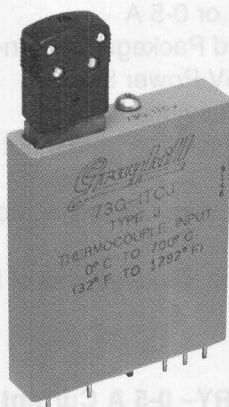
Input Type	Range	Resolution	Part Number
Current	0 to 20 mA	4.88 μ A	73G-II020
Current	4 to 20 mA	3.91 μ A	73G-II420
Current	0 to 5 A	1.22 mA	73G-II5000

*Contact Grayhill for availability.

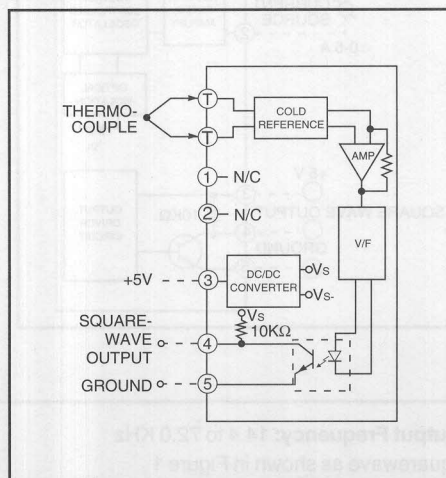
THERMOCOUPLE INPUT MODULES

FEATURES

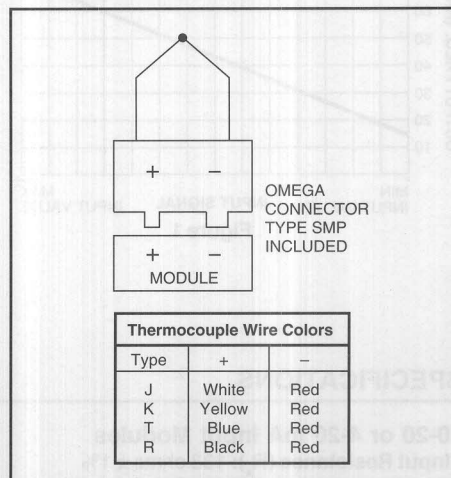
- Temperature Input Modules for Type J, K, R and T Thermocouples
- Temperature Input Module for AD590 Temperature Probes
- Standard Package and Pin-out
- Single 5V Power Supply
- 12 Bit Resolution
- Optical Isolation from Input to Output
- Cold Junction Temperature Compensated Connector Included
- Intermix With G5 Digital Modules on the Same Rack
- Meets the Requirements of IEEE 472



CIRCUITRY



CONNECTOR WIRING



SPECIFICATIONS

Temperature Input Modules

Common Mode Reject: > 100dB

Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc

Supply Current at 5 Vdc: 150 mA max.

Output Frequency: 14.4 to 72.0 KHz, squarewave as shown in Figure 1

Squarewave Amplitude: 0 to V_{cc} -10% min.

Squarewave Duty Cycle: 40% to 60%

Accuracy, Across Range at 25°C: ±3.0°C

Offset Drift: ±100 PPM/°C

Gain Drift: ±55 PPM/°C

Response Time: Output frequency

changes within 2.5 ms of a full scale input change.

Additional Characteristics

Isolation (Input to Output): 2500 Vrms

Isolation (Input to Power Supply): 2500 Vrms

Operating Temperature Range: 0° to 60°C

Storage Temperature Range: -25° to 85°C

Connection: Connect thermocouple wires to the male half of the connector (included). Then plug it in to the female connector on top of the module. The connector is cold junction temperature compensated.

Operation

Thermocouples do not provide a linear millivolt-to-degree signal. Thermocouple modules are linear devices which do not compensate for the thermocouple signal. The signal can be linearized with the use of a Grayhill MicroDAC controller or application algorithm.

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

Available from your local Grayhill Distributor

For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

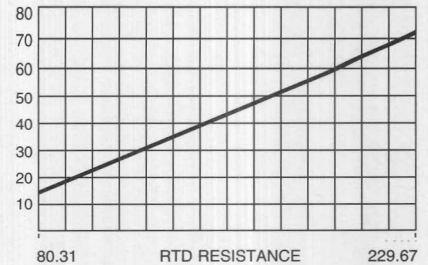
ORDERING INFORMATION

Input Type	Input Range	Resolution	Part No.
J Thermocouple	0 to 700°C (32 to 1292°F)	0.18°C (0.32°F)	73G-ITCJ
K Thermocouple	-100 to 924°C (-148 to 1695°F)	0.25°C (0.45°F)	73G-ITCK
R Thermocouple	0 to 960°C (32 to 1760°F)	0.23°C (0.42°F)	73G-ITCR
T Thermocouple	-200 to 224°C (-328 to 435°F)	0.10°C (0.19°F)	73G-ITCT
AD590 Probe	-188 to 150°C (-307 to 302°F)	0.08°C (0.15°F)	73G-ITP590*

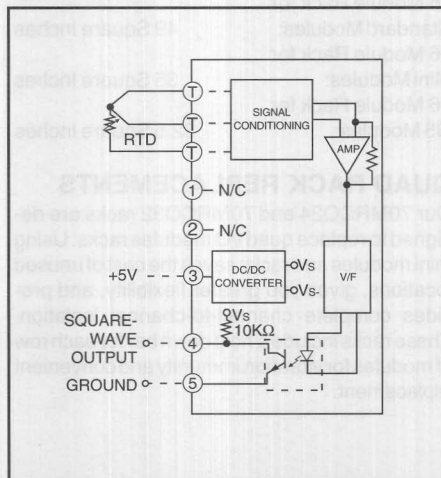
*Contact Grayhill for availability.

FEATURES

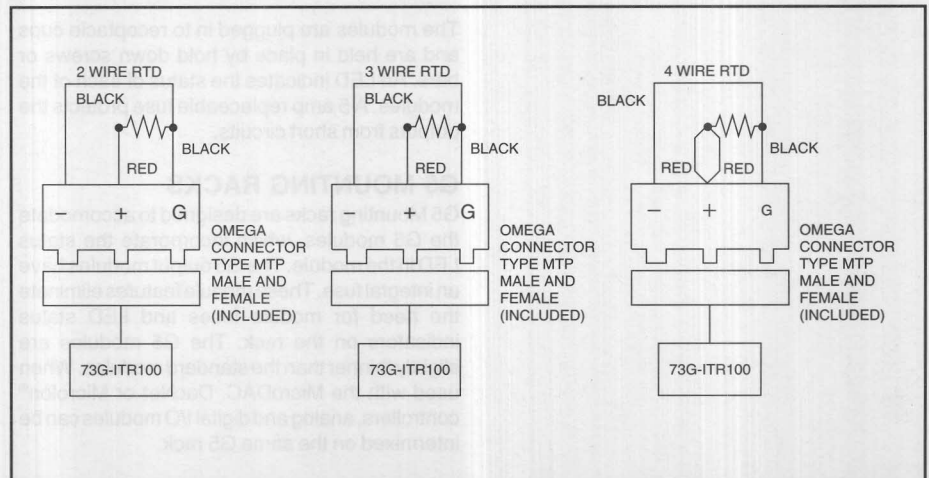
- Temperature Input Module for 100 Ohm Platinum RTDs
- Standard Package and Pin-out
- Single 5V Power Supply
- 12 Bit Resolution
- Optical Isolation from Input to Output
- Intermix With G5 Digital Modules on the Same Rack
- Meets the Requirements of IEEE 472



CIRCUITRY



CONNECTOR WIRING



SPECIFICATIONS

Temperature Input Modules
Common Mode Reject: > 100dB
Supply Voltage (V_{cc}) Range: 4.5 - 5.5 Vdc
Supply Current at 5 Vdc: 150 mA max.
Output Frequency: 14.4 to 72.0 KHz, squarewave as shown in Figure 1 on previous page.
Squarewave Amplitude: 0 to V_{cc} -10% min.
Squarewave Duty Cycle: 40% to 60%
Accuracy, Across Range at 25°C: $\pm 0.8^\circ\text{C}$
DIN 43760 standard
Temperature Coefficient (α): 0.00385
Response Time: Output frequency changes within 2.5 mS of a full scale input change.

Additional Characteristics
Isolation (Input to Output): 2500 Vrms
Isolation (Input to Power Supply): 2500 Vrms
Operating Temperature Range: 0° to 60°C
Storage Temperature Range: -25° to 85°C
Connection: Connect RTD wires to the male half of the connector (included) as shown above. Then plug it in to the female connector. Minimum wire length is 5.5 inches.

Operation

An RTD applied at the given input range is nearly linear (less than 0.1% deflection across the range). The RTD Input Module does not further linearize the signal. Contact Grayhill if higher accuracies are required.

DIMENSIONS

For complete dimensional drawings, see pages I-4 to I-5.

Available from your local Grayhill Distributor
 For prices and discounts, contact a local Distributor, a local Sales Office, or Grayhill.

ORDERING INFORMATION

Input Type	Range	Resolution	Part Number
100 ohm Plat. RTD	-50 to 350°C (-58 to 662°F)	0.10°C 0.18°F	73G-ITR100

MOUNTING RACKS

- Replaceable Fuses
- LED Status Indicators
- UL Recognized: File No. E94540
- CSA Certified: File No. LR38763
- Terminal Numbers Always Visible, Even After Wiring
- Form, Fit and Function Equivalents to Competition

STANDARD MOUNTING RACKS

Mounting racks provide a convenient method of connecting to I/O modules. Most racks have the option of a card edge or header connector for the logic signals. Field wires get connected to open or closed terminal blocks.

The modules are plugged in to receptacle cups and are held in place by hold down screws or bars. An LED indicates the status of each of the modules. A 5 amp replaceable fuse protects the outputs from short circuits.

G5 MOUNTING RACKS

G5 Mounting racks are designed to accommodate the G5 modules, which incorporate the status LED in the module. The G5 output modules have an integral fuse. These module features eliminate the need for module fuses and LED status indicators on the rack. The G5 modules are slightly thinner than the standard modules. When used with the MicroDAC, DacNet or Microlon® controllers, analog and digital I/O modules can be intermixed on the same G5 rack.

MINIATURE SIZED RACKS

Our mini and G5 racks are much smaller than the industry standard racks. A rack of 16 modules occupies 71% of the area needed for standard modules.

16 Module Rack for Standard Modules:	49 Square Inches
16 Module Rack for Mini Modules:	35 Square Inches
16 Module Rack for G5 Modules:	32.5 Square Inches

QUAD RACK REPLACEMENTS

Our 70MRCQ24 and 70MRCQ32 racks are designed to replace quad I/O modules racks. Using mini modules and racks saves the cost of unused locations, gives you greater flexibility, and provides complete channel-to-channel isolation. These racks include a hold down bar for each row of modules for vibration immunity and convenient replacement.

ENGINEERING INFORMATION

Engineering Information	I-25
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MOUNTING RACK SELECTION

4 Module Racks

For Standard, G5 Modules	I-27
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8 Module Racks

For Standard Modules	I-29
For Miniature, G5 Modules	I-30

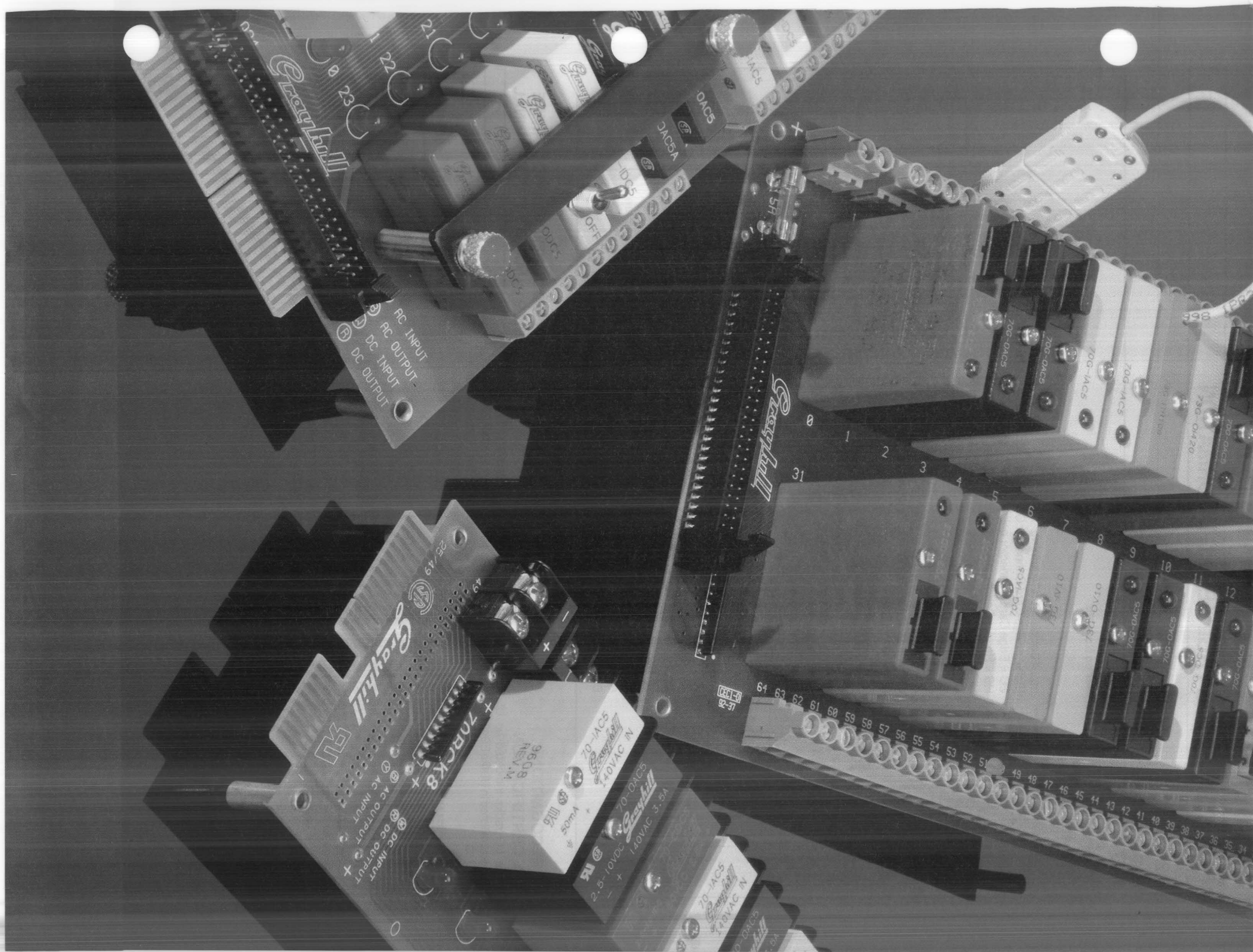
16 Module Racks

For Standard Modules	I-32
For Miniature, G5 Modules	I-33

24 Module Racks

For Standard Modules	I-37
For Miniature Modules	I-38
For Quad Pack Miniature Modules	I-39
For G5 Modules	I-41

32 Module Racks For MicroDAC G5 Modules	I-43
For Parallel Controller Board G5 Modules	I-45



MOUNTING RACK ENGINEERING INFORMATION

PART NUMBER EXPLANATION—I/O RACKS

Series Number

70MRCK16-HS

Input Connection/Mounting

Blank = Edge Card Connector Only for Standard I/O (*Note 1*)
 EC = Edge Card Connector only for Mini I/O (*Note 1*)
 HS = Header Connector—short ejector levers (*Note 2*)
 HL = Header Connector—long ejector levers (*Note 3*)
 DIN = DIN Rail Mount

Number of Modules or Rack Positions

4 = 4 Modules
 4R = 4 Modules, Positive or Negative True Logic
 8 = 8 Modules
 16 = 16 Modules
 16T = Terminal Blocks for Control and Field Wiring
 16 = Terminal Blocks for Control and Field Wiring—Positive or negative true logic
 24 = 24 Modules
 32 = 32 Modules

Mounting Rack Type

K = 1 Row of Modules in Line
 Q = 2 Rows of Modules (*Mini racks replace Quad racks*)
 M = Special 32 Position G5 Rack for MicroDAC
 P = Special 32 Position G5 Rack for Parallel Controller Board

RC = Mounting Rack

Module Type

M = Mini I/O Module
 G = G5 Series I/O Module
 Blank = Standard I/O Module

Note 1— 50 pin card edge mates with 3M part number 3415-0001 or equivalent.

Note 2— Racks with short ejector levers mate with ribbon cable connectors without strain relief (Molex part number 15-29-7750 or equivalent).

Note 3— Racks with long ejector levers mate with ribbon cable connectors with strain relief (Molex part number 15-29-9350 or equivalent) or discrete wire connectors (Molex part number 22-55-2502 or equivalent).

Not all combinations are valid, see Ordering Information.

UL RECOGNITION/ CSA CERTIFICATION

Those I/O racks indicated as UL and CSA certified are listed in UL file E94540 and CSA file LR38763.

REPLACEMENT FUSES

All I/O locations on standard and mini I/O racks are fused with 5A Littlefuse 251-005 or Bussman GFA5 fuses. Logic supply on 24 and 32 position standard and mini I/O racks are fused with 1A Littlefuse 251-001 or Bussman GFA1 fuses. Logic supply on 16, 24 and 32 position G5 I/O racks are fused with 5 x 20 mm glass fuses rated 1A or 5A.

I/O MODULE AND FUSE SOCKETS

We recommend customers designing their own I/O racks use Mill-Max part number 0355-0-15-01-02-01-10-0 sockets for the I/O module leads and Mill-Max part number 0660-0-15-01-20-02-10-0 for Littlefuse pico fuse leads.

LOGIC SUPPLY

To power an I/O rack, connect a power supply to the 2 position logic supply terminal block, taking care that the polarity is correct. Alternately, the I/O rack may be powered through the 50 pin connector. Pin 49 on all other racks is +Vcc. A jumper or fuse may have to be installed on the I/O rack to complete this connection. See details on the following pages.

FIELD TERMINAL BLOCK-WIRE SIZE QUANTITY PER TERMINAL

I/O Rack Type	AWG			
	10	12	14	16
Mini	—	—	1	2
G5	1	1	2	3

JUMPER BARS

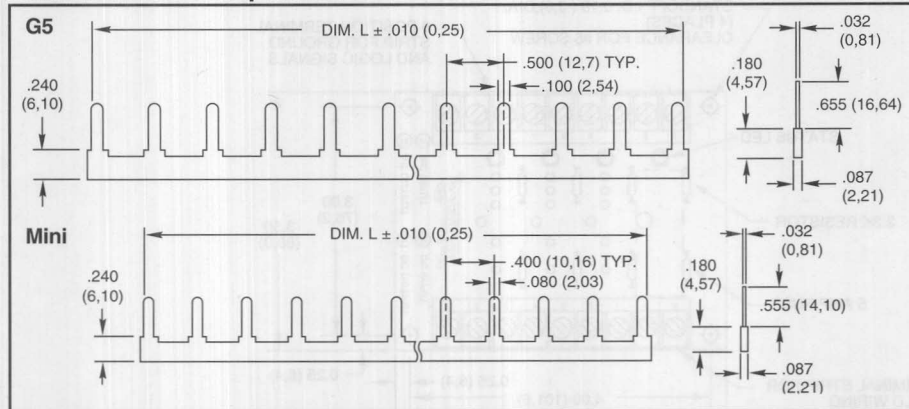
Grayhill jumper bars are available for applications that require common terminals to be bussed together on digital I/O mounting racks. Jumper bars are available for both our Mini and G5 racks. Grayhill jumper bars are made from .032" thick tin plated brass. The jumper bars are insulated with a molded sleeve for excellent dielectric properties.

ORDERING INFORMATION

Jumper Bars for Grayhill G5 and Mini Series I/O Racks

Part Number	Description	Dimension "L" inches (mm)	Use on Grayhill I/O Rack
70G-JUMP8	8 position jumper for G5 I/O racks	3.60 (81,44)	70GRCK8-HL, 70GRCK16-HL, 70GRCK32-HL, 70GRCP32-HL, 70GRCK16I, 70GRCK16T, 70GRCK24-HL
70G-JUMP12	12 position jumper for G5 I/O racks	5.60 (142,24)	
70M-JUMP6	6 position jumper for Mini I/O racks	2.08 (52,83)	70MRCQ24-HL
70G-JUMP12	8 position jumper for G5 I/O racks	2.88 (73,15)	70MRCK8-HL, 70MRCK16-HL, 70MRCK24-HL

DIMENSIONS—Jumper Bars

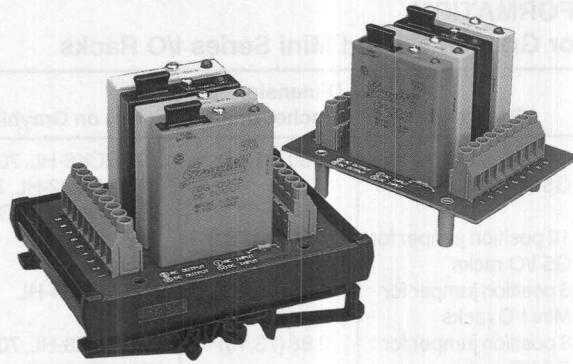


PROPER CONTROLLER BOARD—I/O RACK COMBINATIONS

	Standard I/O Racks			Mini I/O Racks				G5 I/O Racks				
	70RCK8-HL	70RCK16-HL	70RCK24-HL	70MRCK8-HL	70MRCK16-HL	70MRCK24-HL	70MRCQ24-HL	70GRCK8-HL	70GRCK16-HL	70GRCK24-HL	70GRCK32-HL	70GRCP32-HL
Controller Part No.												
72-PC5-24D	x	x	x	x	x	x	x	x	x	x		
72-PMX-24D	x	x	x	x	x	x	x	x	x	x		
72-PMX-32D												x
72-PMO-1	x	x	x	x	x	x	x	x	v	x		
72-PMO-3	x	x	x	x	x	x	x	x	x	x		
72-MDC-32D	x	x	x	x	x	x	x	x	x	x	x	
72-MDC-32AD	x	x	x	x	x	x	x	x	x	x	x	
72-MDC-32DC	x	x	x	x	x	x	x	x	x	x	x	
72-MDC-32ADC	x	x	x	x	x	x	x	x	x	x	x	
72-MDL-32AD	x	x	x	x	x	x	x	x	x	x	x	
72-MDL-32AD	x	x	x	x	x	x	x	x	x	x	x	
72-MDL-32ADC	x	x	x	x	x	x	x	x	x	x	x	
72-MDL-32ADC	x	x	x	x	x	x	x	x	x	x	x	
72-LON-8AD-78P	x			x				x				
72-LON-8AD-12P	x			x				x				
72-LON-8AD-FTTP	x			x				x				
72-LON-8AD-78C	x			x				x				
72-LON-8AD-12C	x			x				x				
72-LON-8AD-FTTC	x			x				x				
72-DNT-32AD	x	x	x	x	x	x	x	x	x	x	x	
72-DNTE-32AD	x	x	x	x	x	x	x	x	x	x	x	

x denotes proper controller board and I/O rack combinations

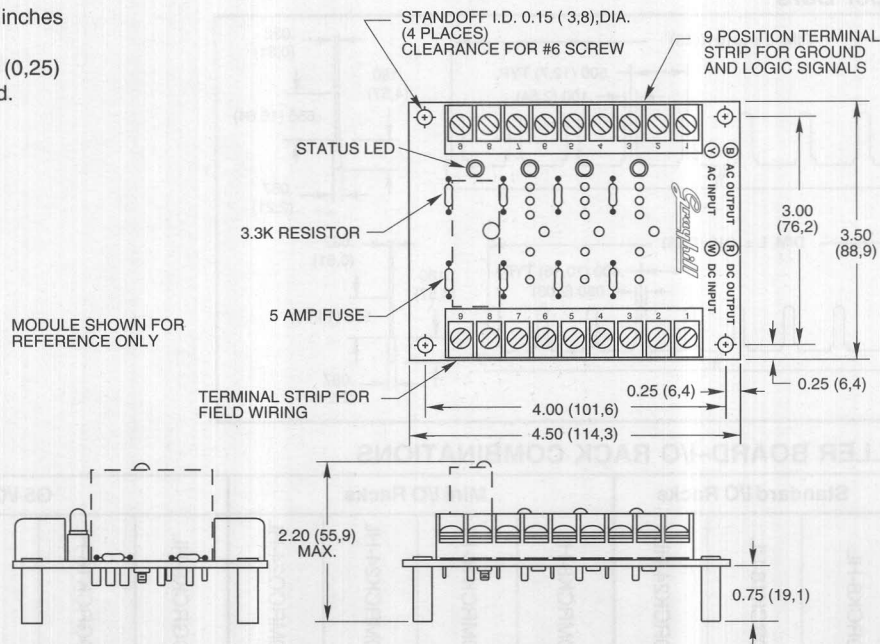
MOUNTING RACKS



4 MODULE RACK-Standard

Part No. 70RCK4

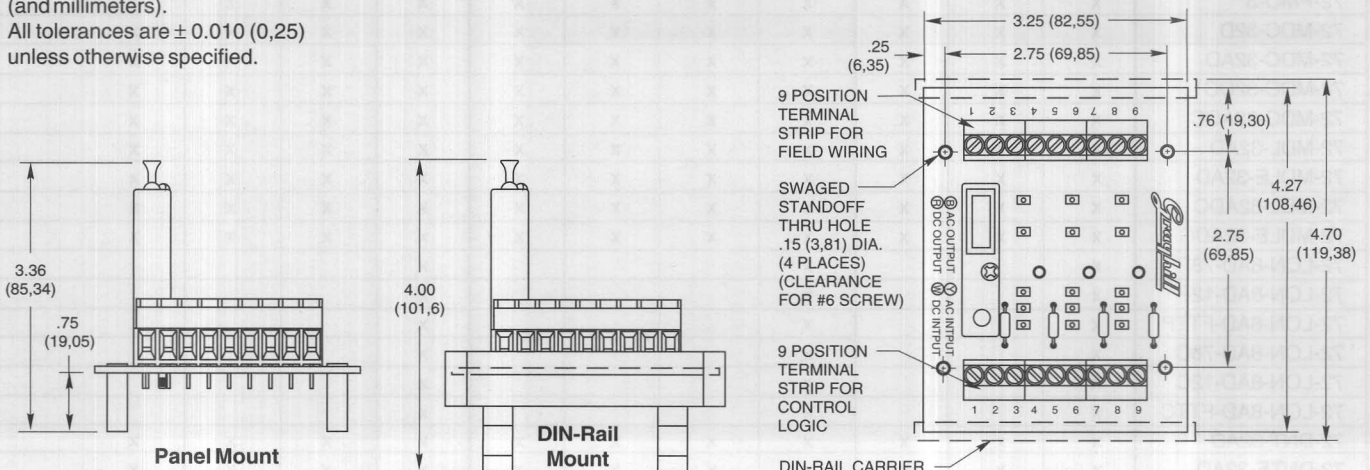
Dimensions are shown in inches (and millimeters).
All tolerances are ± 0.010 (0,25) unless otherwise specified.



4 MODULE RACK-G5

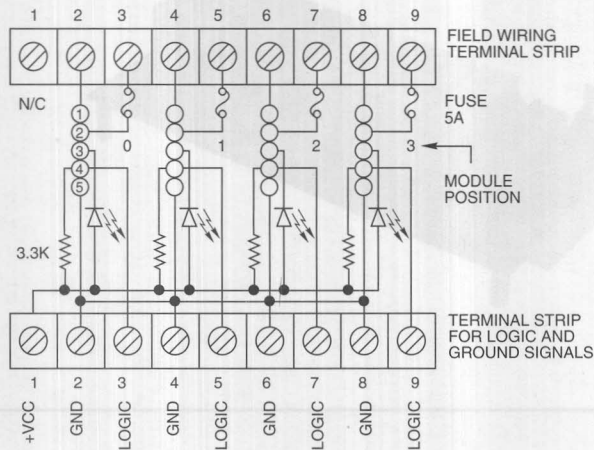
Part No. 70GRCK4

Dimensions are shown in inches (and millimeters).
All tolerances are ± 0.010 (0,25) unless otherwise specified.

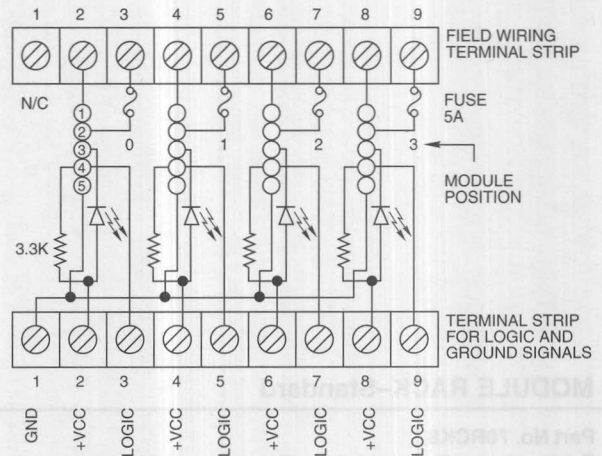


SCHEMATICS—Part No. 70RCK4

70RCK4 For Negative True Logic Only

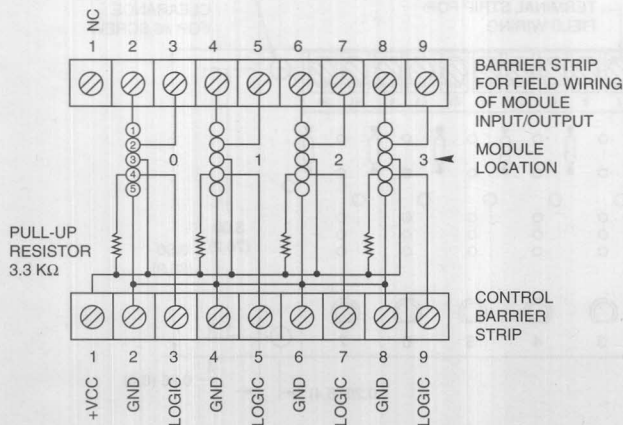


70RCK4R For Negative or Postive True Logic

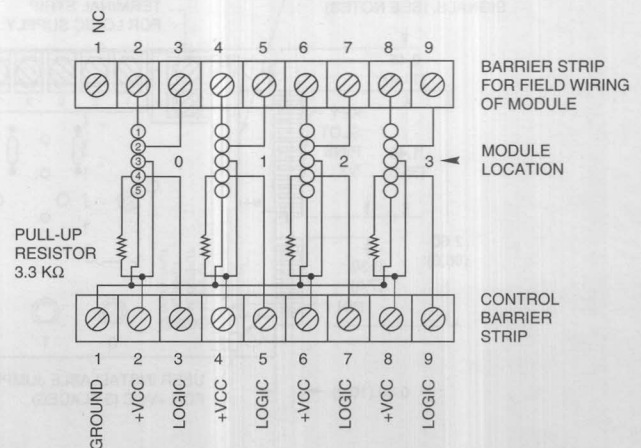


SCHEMATICS—Part No. 70GRCK4

70GRCK4 and 70GRCK4-DIN For Negative True Logic Only



70GRCK4R and 70GRCK4R-DIN For Negative or Postive True Logic



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70RCK4	4	Negative true logic	X	X	Standard
70RCK4R	4	Positive or negative true logic*	X	X	Standard
70GRCK4	4	Negative true logic	X	X	G5
70GRCK4R	4	Positive or negative true logic*	X	X	G5
70GRCK4-DIN	4	Negative true logic—DIN rail mount	X	X	G5
70GRCK4R-DIN	4	Positive or negative true logic*—DIN rail mount	X	X	G5

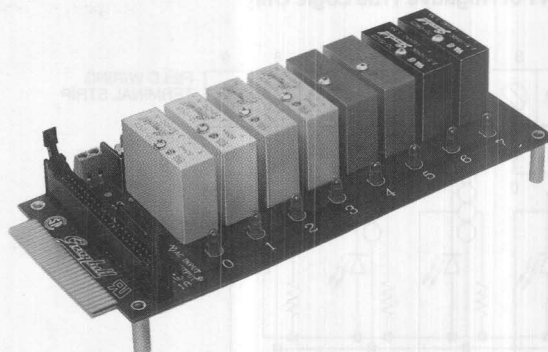
*Note: Positive True Logic applies to output modules only.

ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MOUNTING RACKS



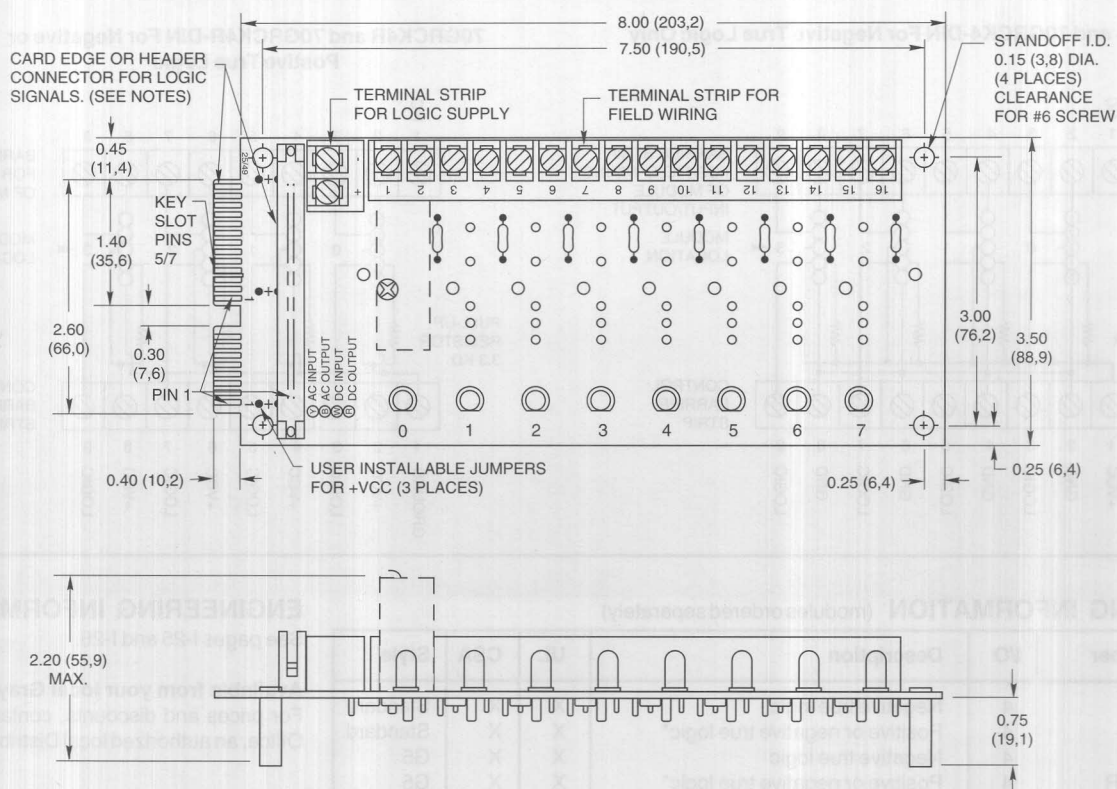
8 MODULE RACK-Standard

Part No. 70RCK8

Schematic and Ordering Information on page I-31.

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.

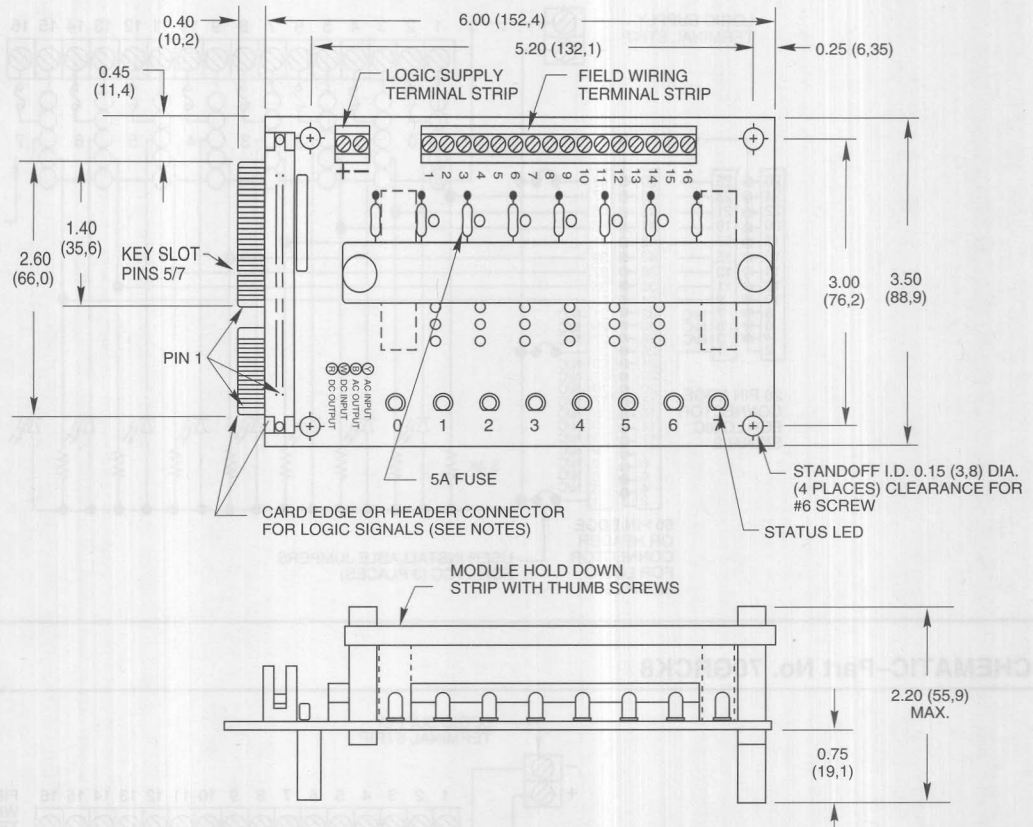


8 MODULE RACK—Miniature

Part No. 70MRCK8

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.

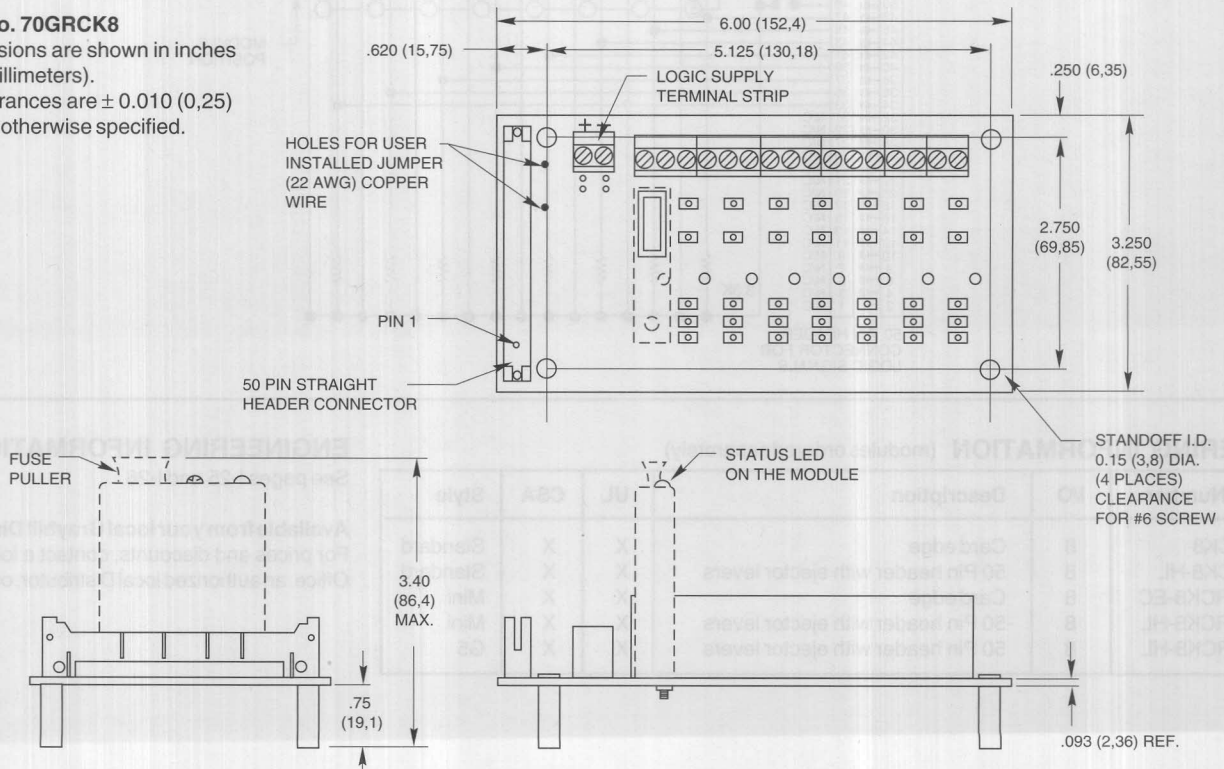


8 MODULE RACK—G5

Part No. 70GRCK8

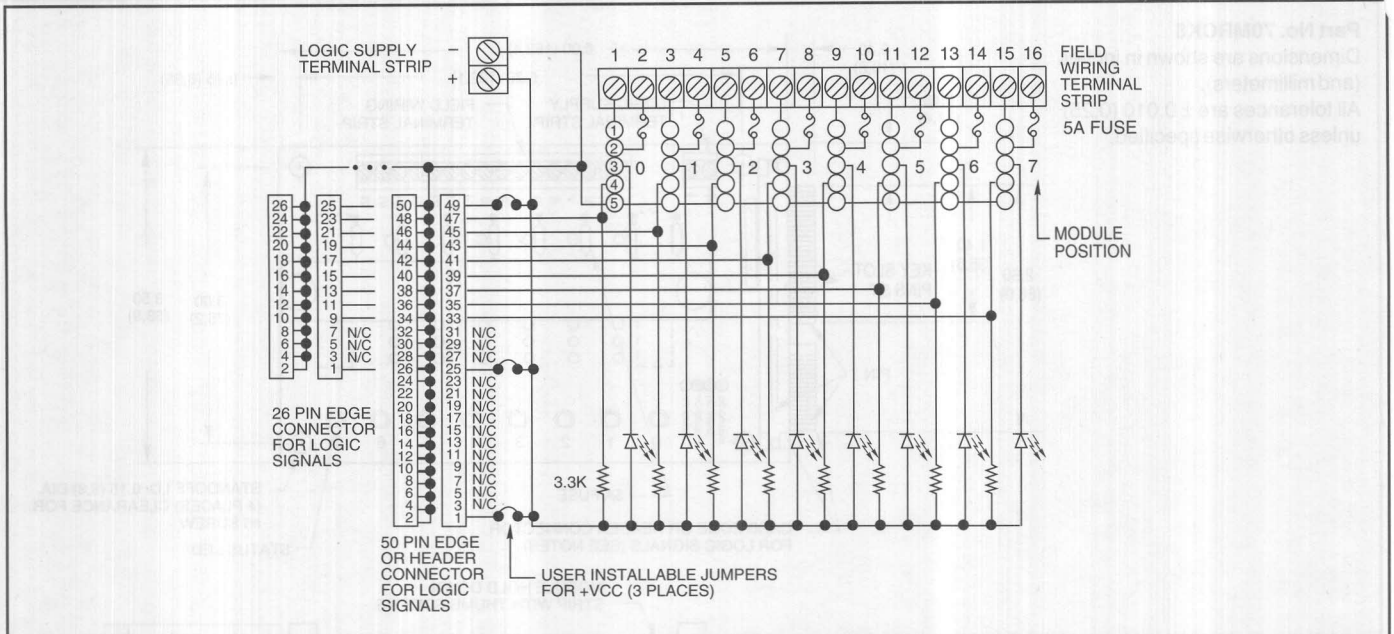
Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.

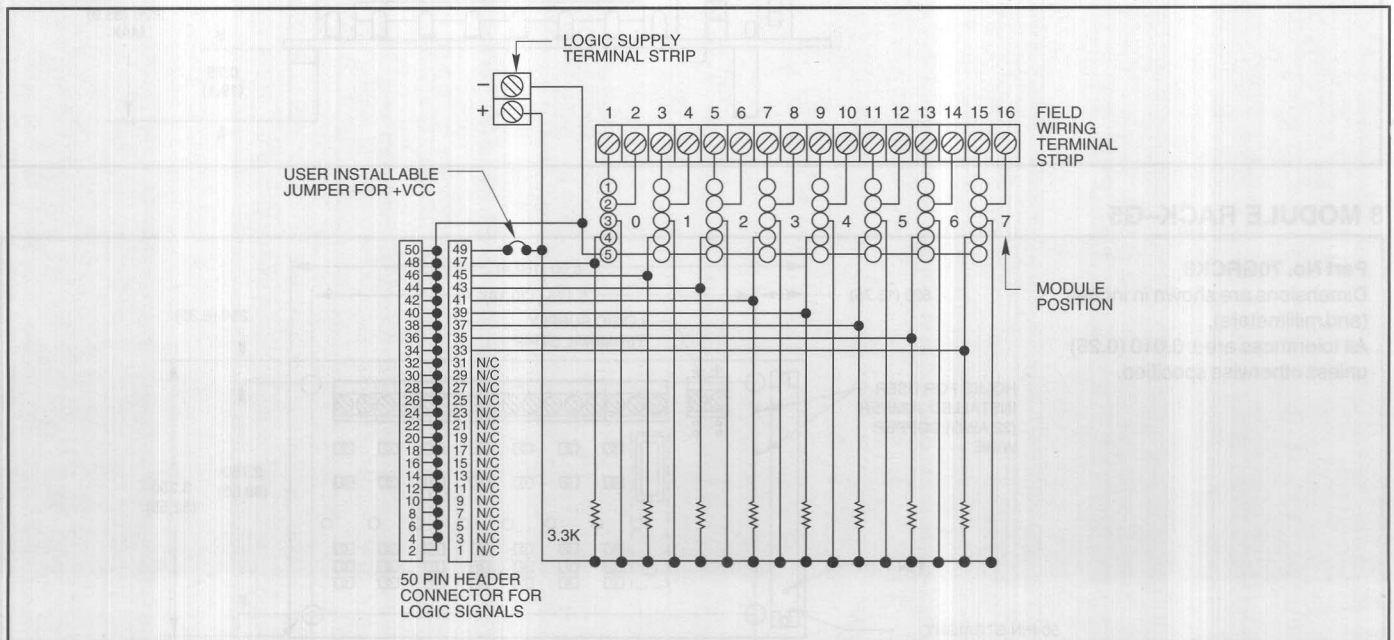


MOUNTING RACKS

SCHEMATIC—Part Nos. 70RCK8, 70MRCK8



SCHEMATIC—Part No. 70GRCK8



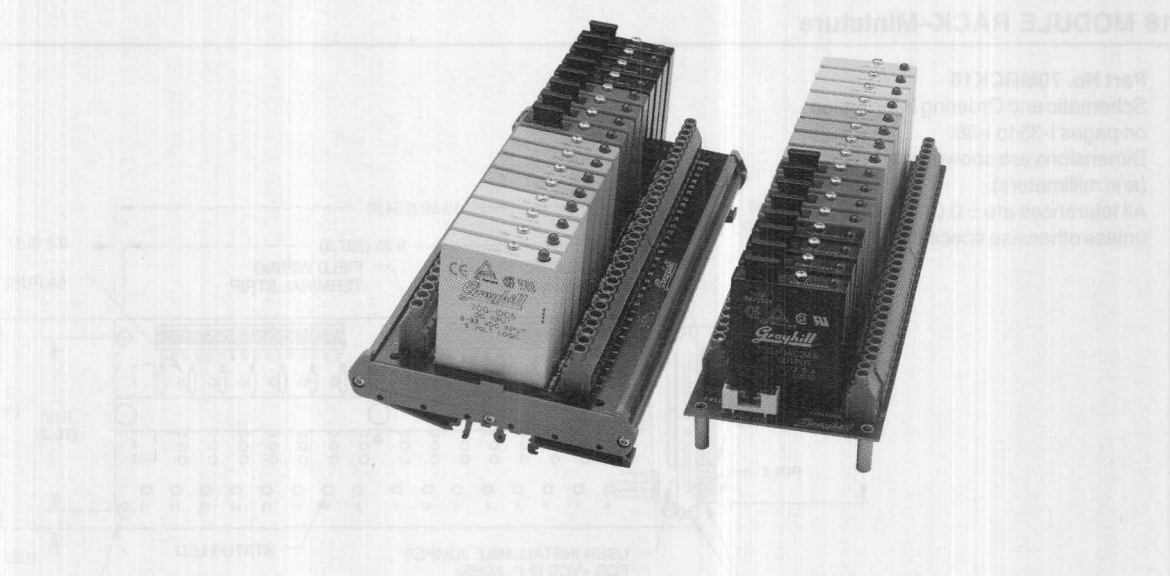
ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70RCK8	8	Card edge	X	X	Standard
70RCK8-HL	8	50 Pin header with ejector levers	X	X	Standard
70MRCK8-EC	8	Card edge	X	X	Mini
70MRCK8-HL	8	50 Pin header with ejector levers	X	X	Mini
70GRCK8-HL	8	50 Pin header with ejector levers	X	X	G5

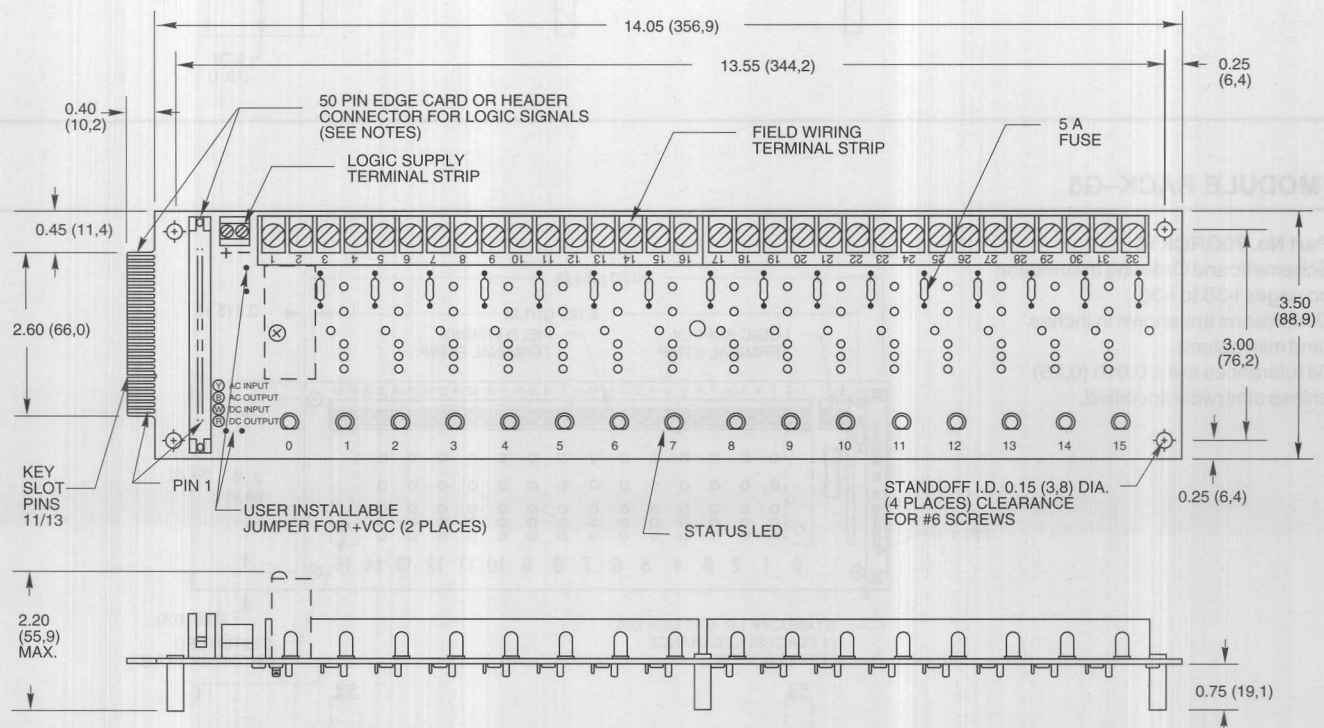
ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.



All tolerances are ± 0.010 (0,25) unless otherwise specified.



MOUNTING RACKS

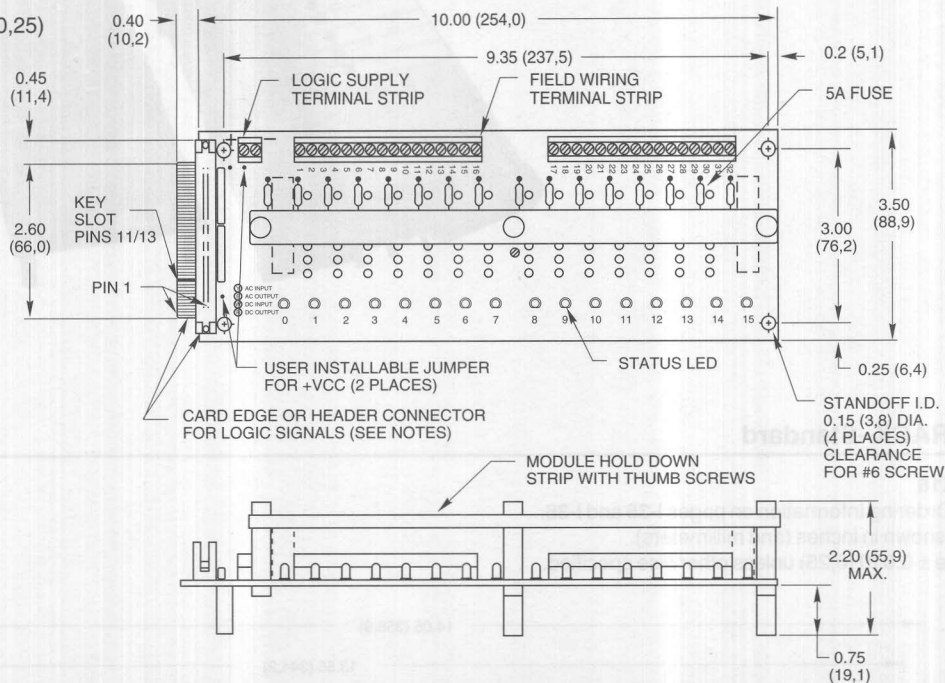
16 MODULE RACK—Miniature

Part No. 70MRCK16

Schematic and Ordering Information on pages I-35 to I-36.

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.



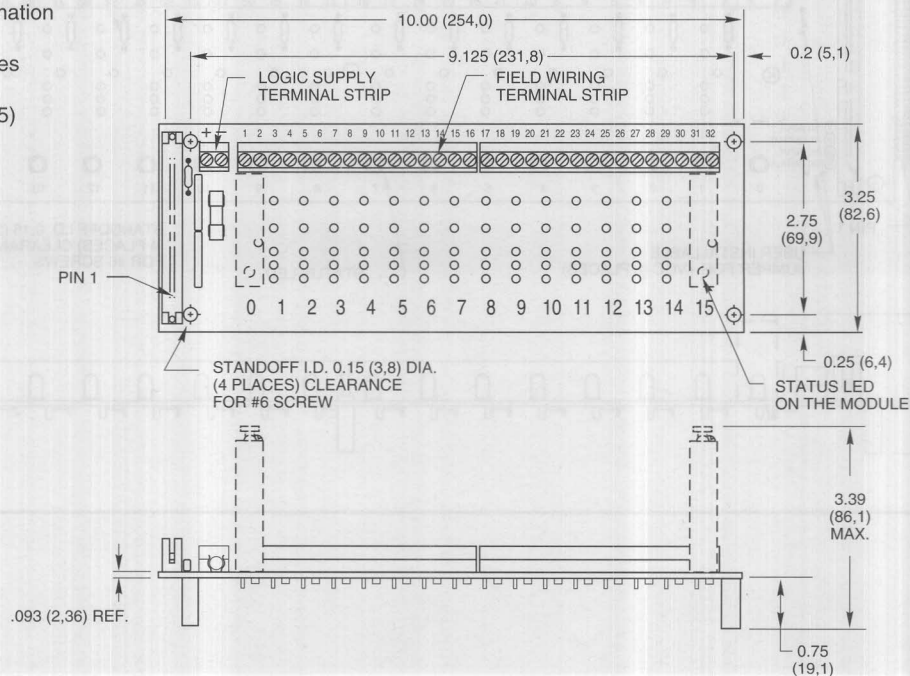
16 MODULE RACK—G5

Part No. 70GRCK16

Schematic and Ordering Information on pages I-35 to I-36.

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.



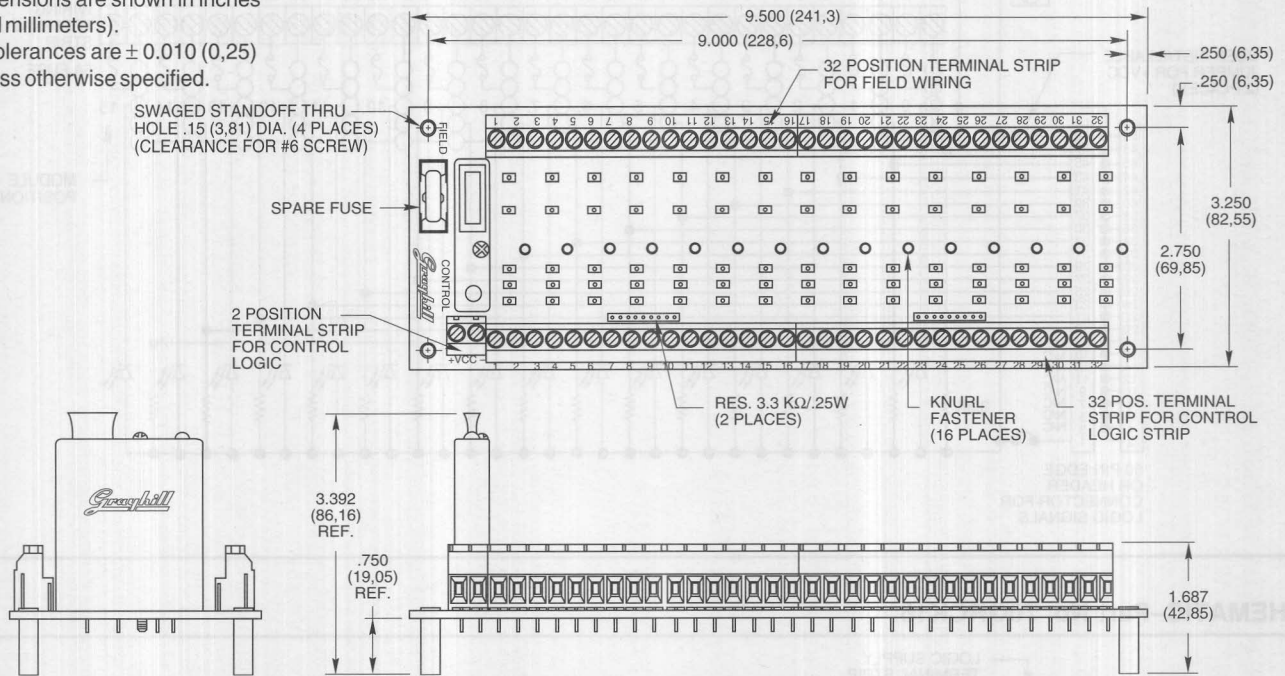
16 MODULE RACK-G5 Control and Field Connection Terminal Blocks

Part No. 70GRCK16T

Schematic and Ordering Information on pages I-35 to I-36.

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.



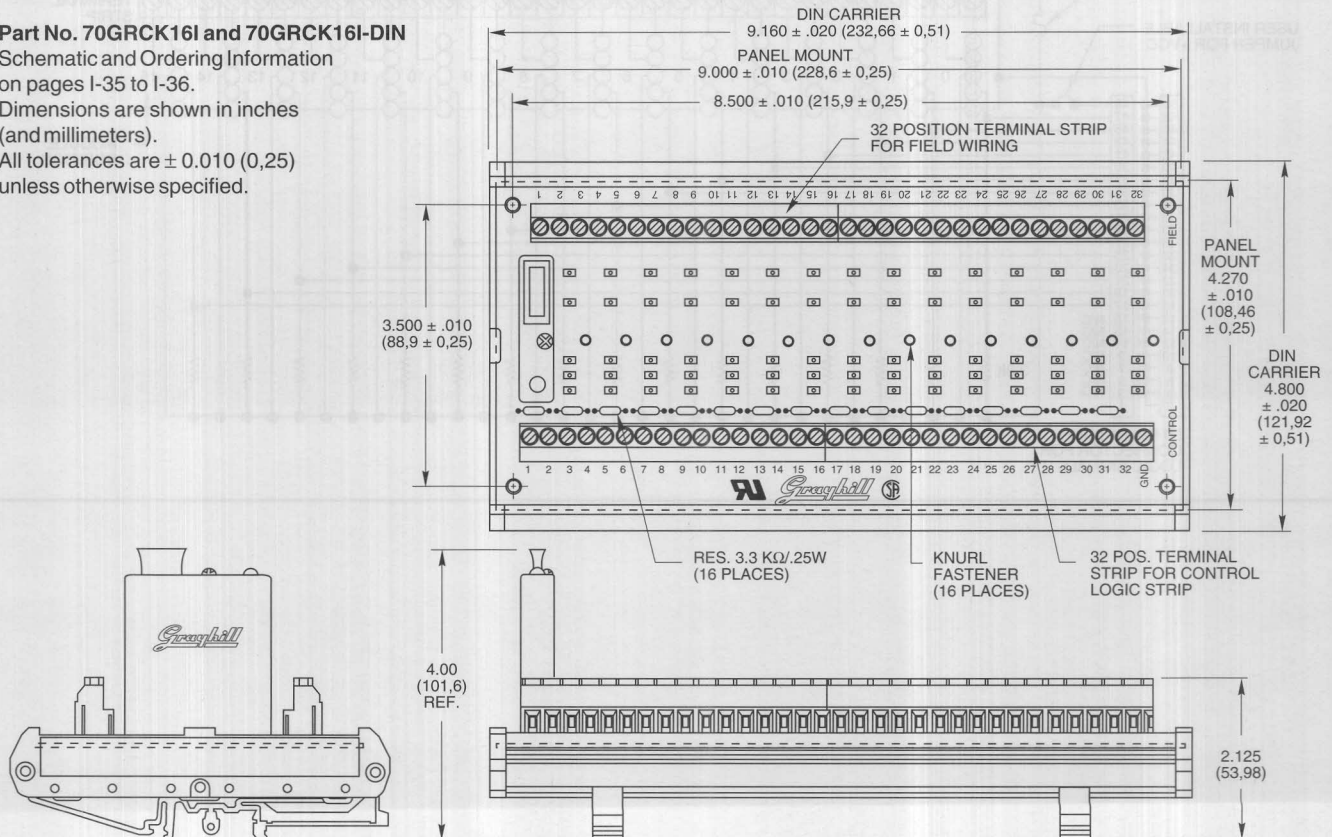
16 MODULE RACK-G5 Channel-to-Channel Isolation

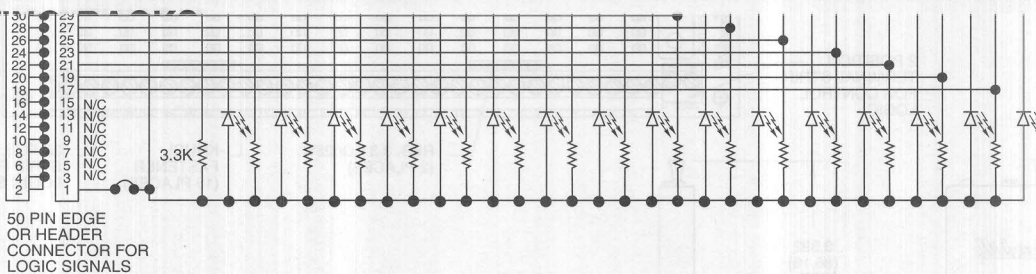
Part No. 70GRCK16I and 70GRCK16I-DIN

Schematic and Ordering Information on pages I-35 to I-36.

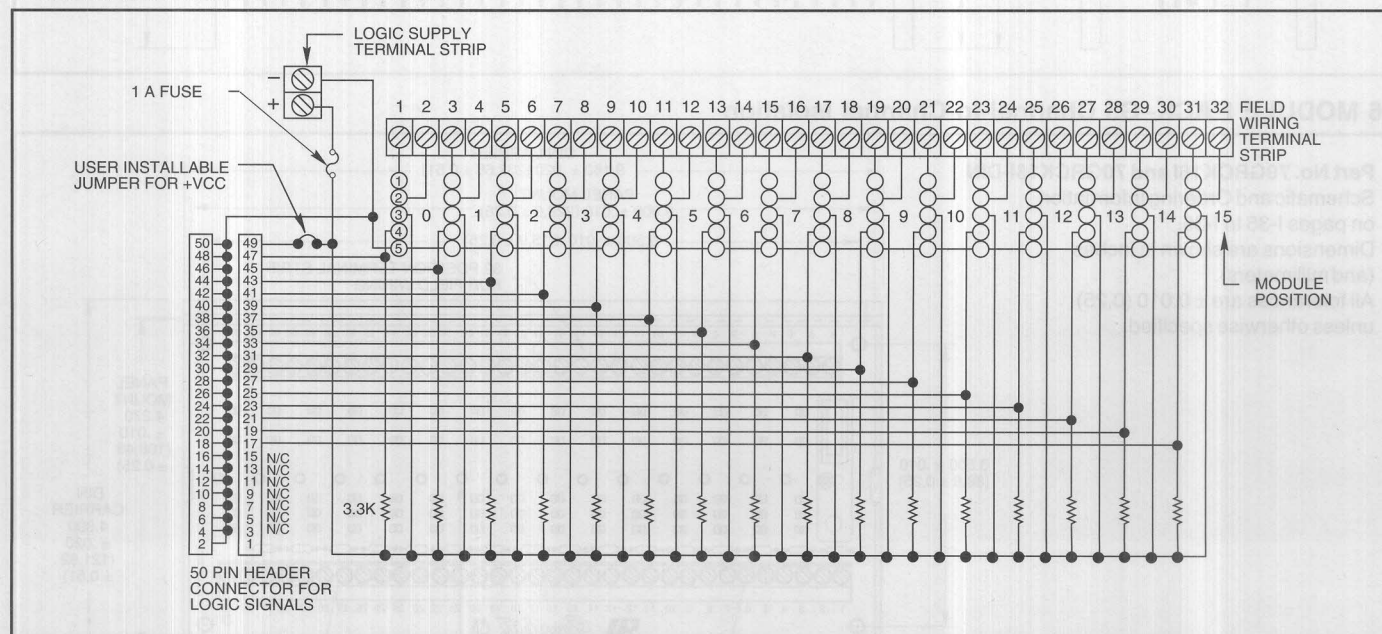
Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.

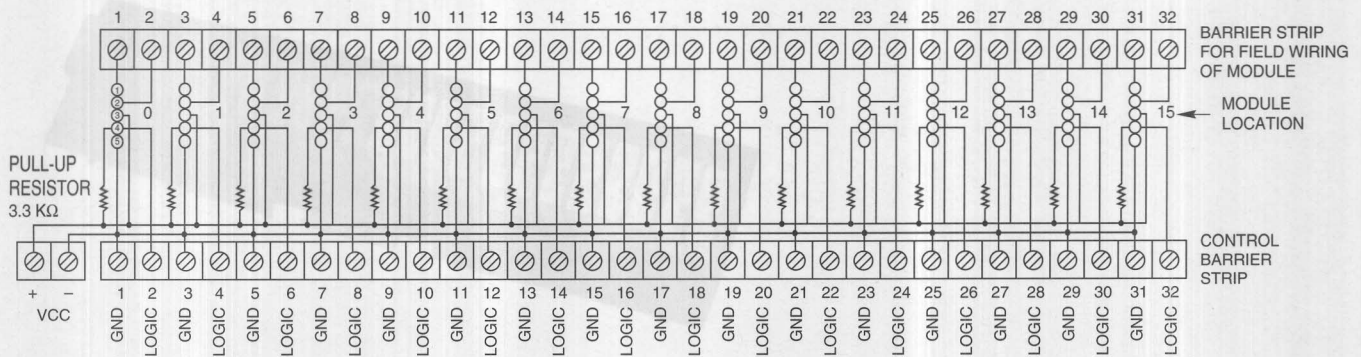




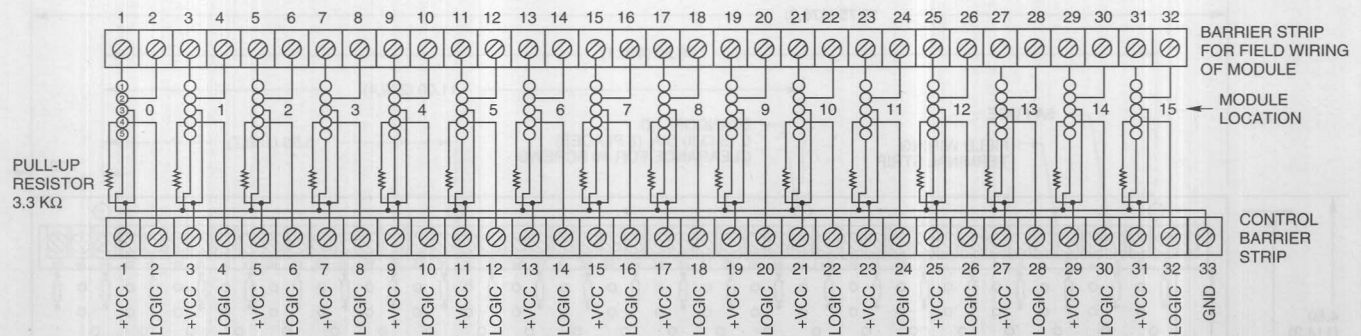
SCHEMATIC-Part No. 70GRCK16



SCHEMATIC—Part No. 70GRCK16T



SCHEMATIC—Part Nos. 70GRCK16I AND 70GRCK16I-DIN



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70RCK16	16	Card edge	X	X	Standard
70RCK16-HL	16	50 Pin header with ejector levers	X	X	Standard
70MRCK16-EC	16	Card edge	X	X	Mini
70MRCK16-HL	16	50 Pin header with ejector levers	X	X	Mini
70GRCK16-HL	16	50 Pin header with ejector levers	X	X	G5
70GRCK16I	16	Positive or negative true logic*— Panel Mount	X	X	G5
70GRCK16I-DIN	16	Positive or negative true logic*— DIN rail mount	X	X	G5
70GRCK16T	16	Negative true logic*—Panel Mount	X	X	G5

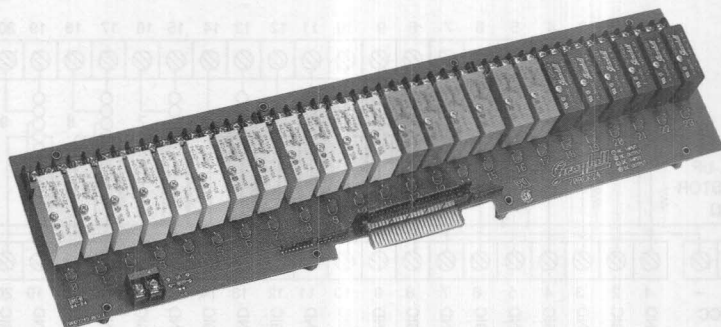
* Positive true logic applies to output modules only.

ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MOUNTING RACKS

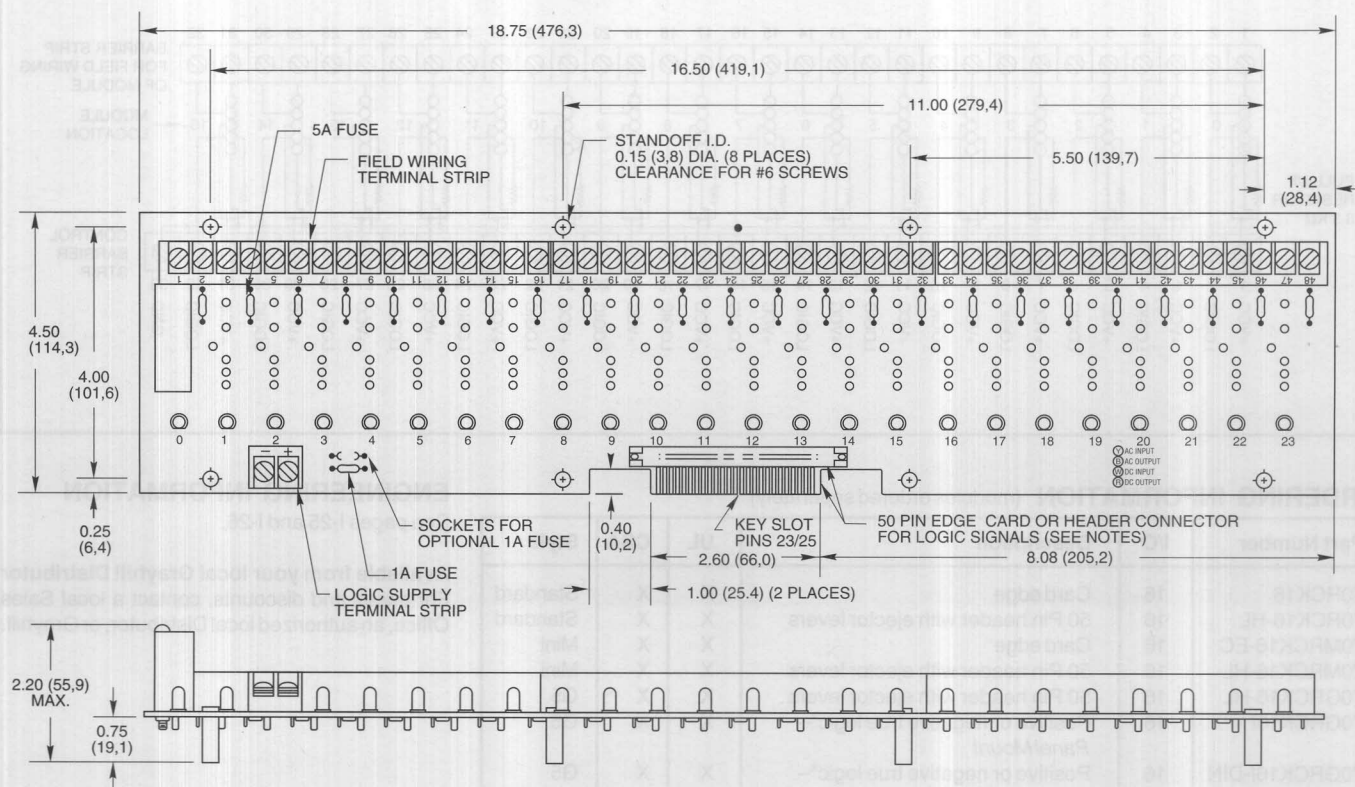


24 MODULE RACK-Standard

Part No. 70RCK24

Dimensions are shown in inches (and millimeters).

Tolerances are ± 0.010 (0,25) unless indicated otherwise.

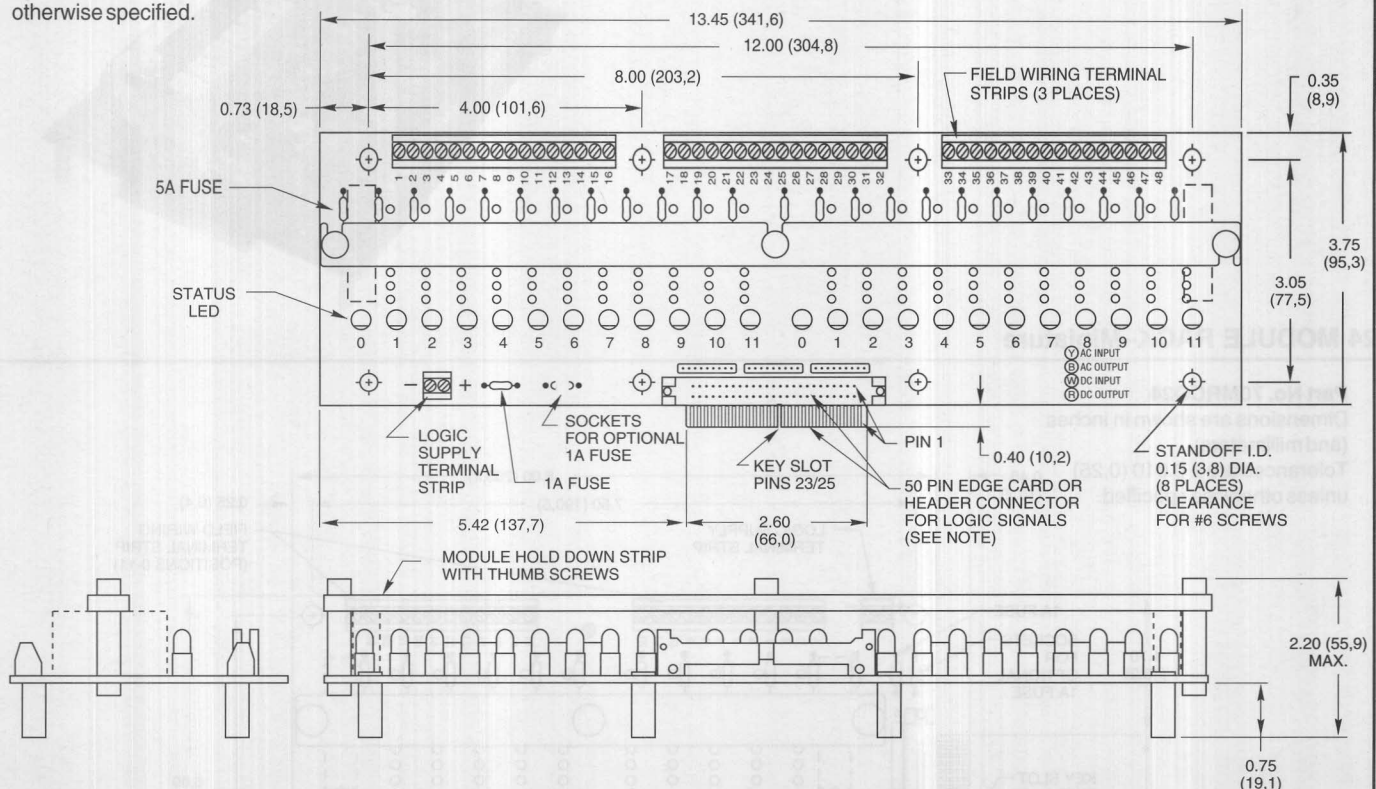


24 MODULE RACK—Miniature

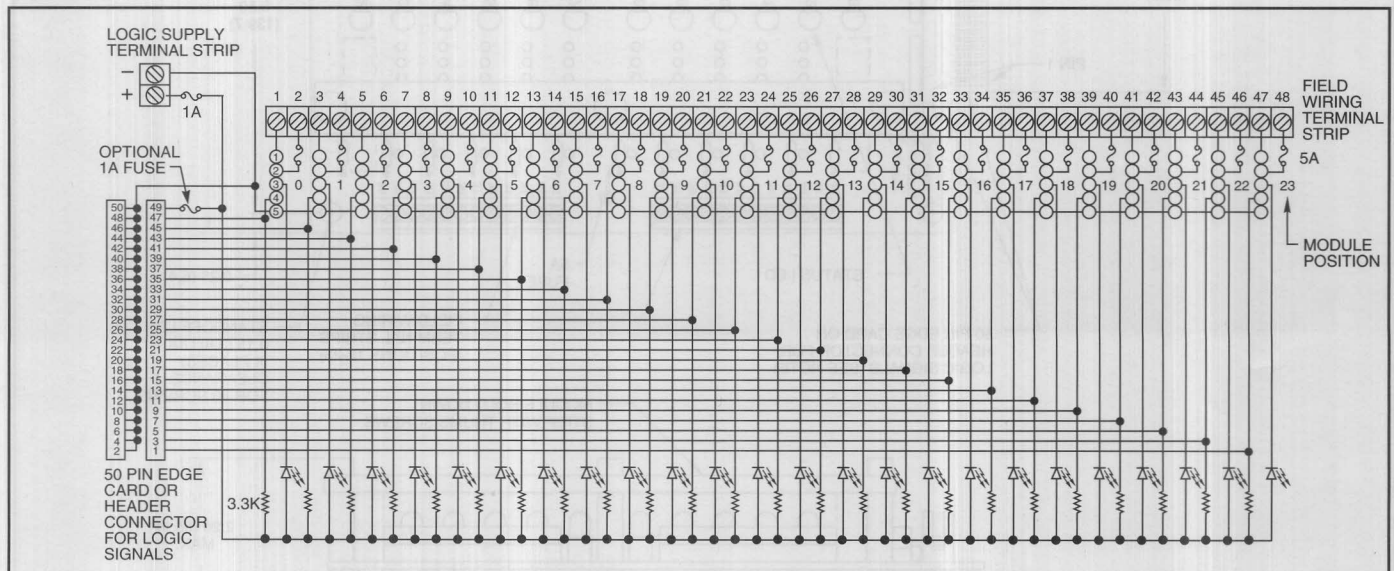
Part No. 70MRCK24

Dimensions are shown in inches (and millimeters).

All tolerances are ± 0.010 (0,25) unless otherwise specified.



SCHEMATIC—Part Nos. 70RCK24 and 70MRCK24



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70RCK24	24	Card edge	X	X	Standard
70RCK24-HL	24	50 Pin header with ejector levers	X	X	Standard
70MRCK24-EC	24	Card edge	X	X	Mini
70MRCK24-HL	24	50 Pin header with ejector levers	X	X	Mini

ENGINEERING INFORMATION

See pages I-25 and I-26.

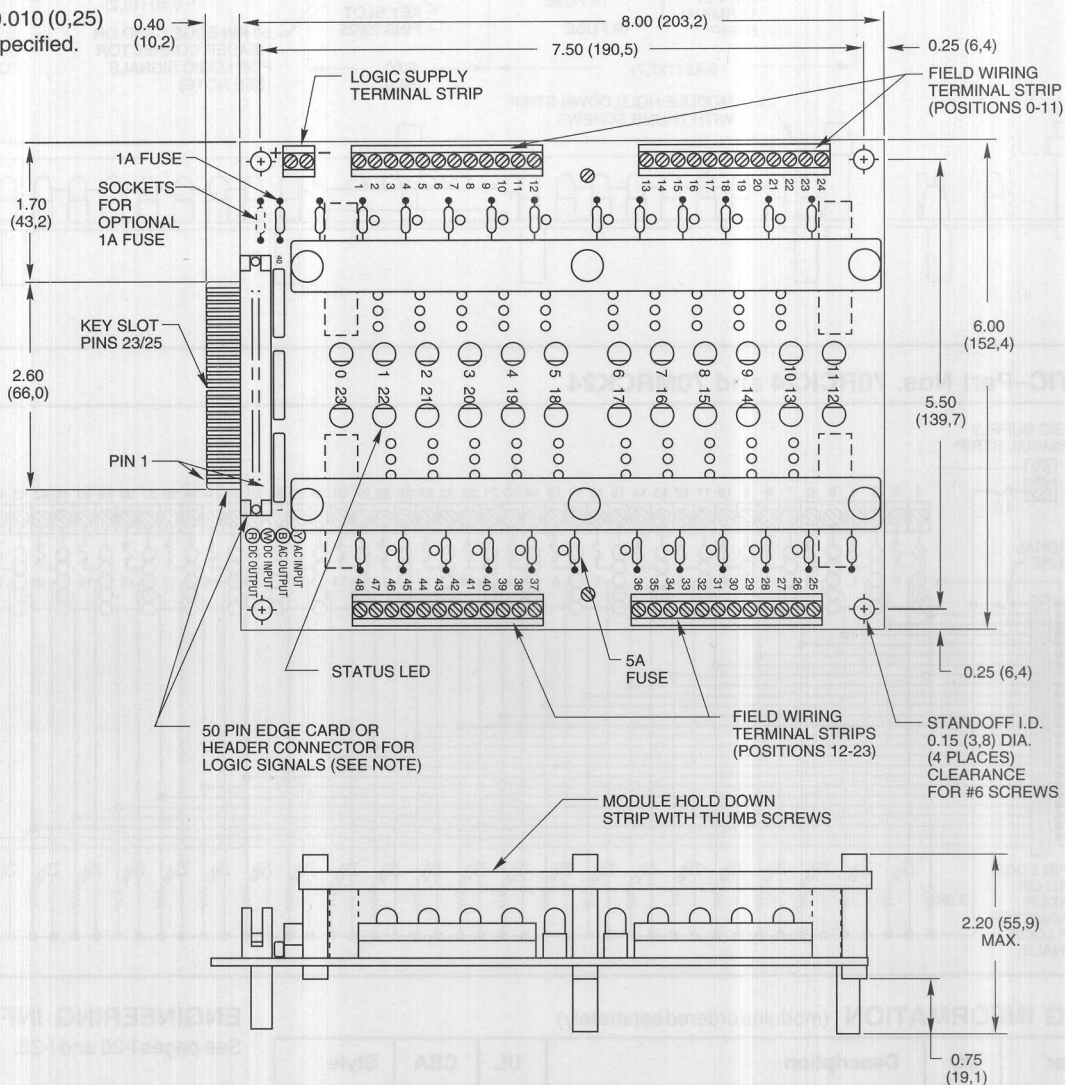
Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

24 MODULE RACK—Miniature

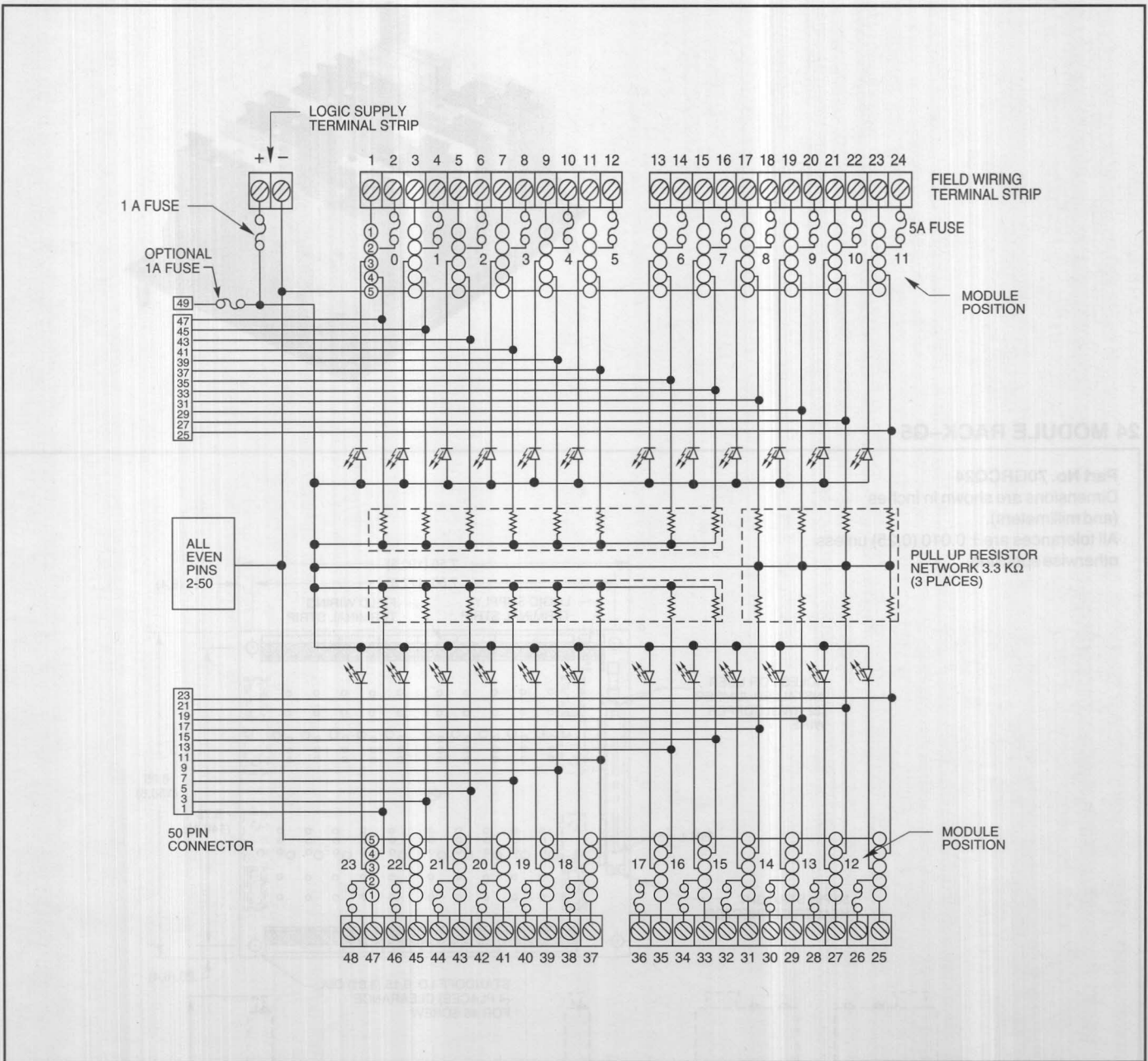
Part No. 70MRCQ24

Dimensions are shown in inches
(and millimeters).

Tolerances are ± 0.010 (0,25)
unless otherwise specified.



SCHEMATIC—Part No. 70MRCQ24



ORDERING INFORMATION (modules ordered separately)

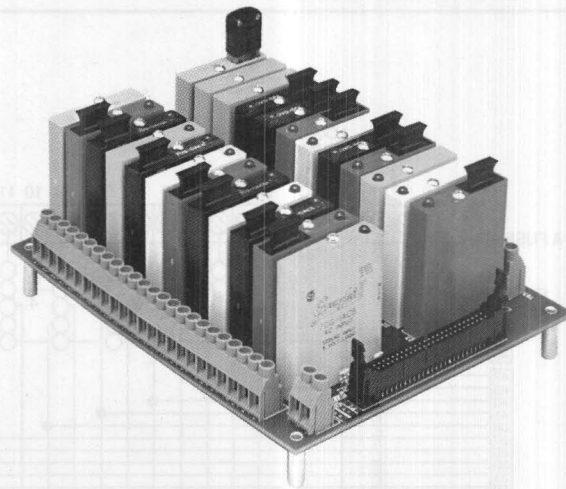
Part Number	I/O	Description	UL	CSA	Style
70MRCQ24-EC	24	Card edge	X	X	Mini
70MRCQ24-HL	24	50 Pin header with ejector levers	X	X	Mini

ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MOUNTING RACKS

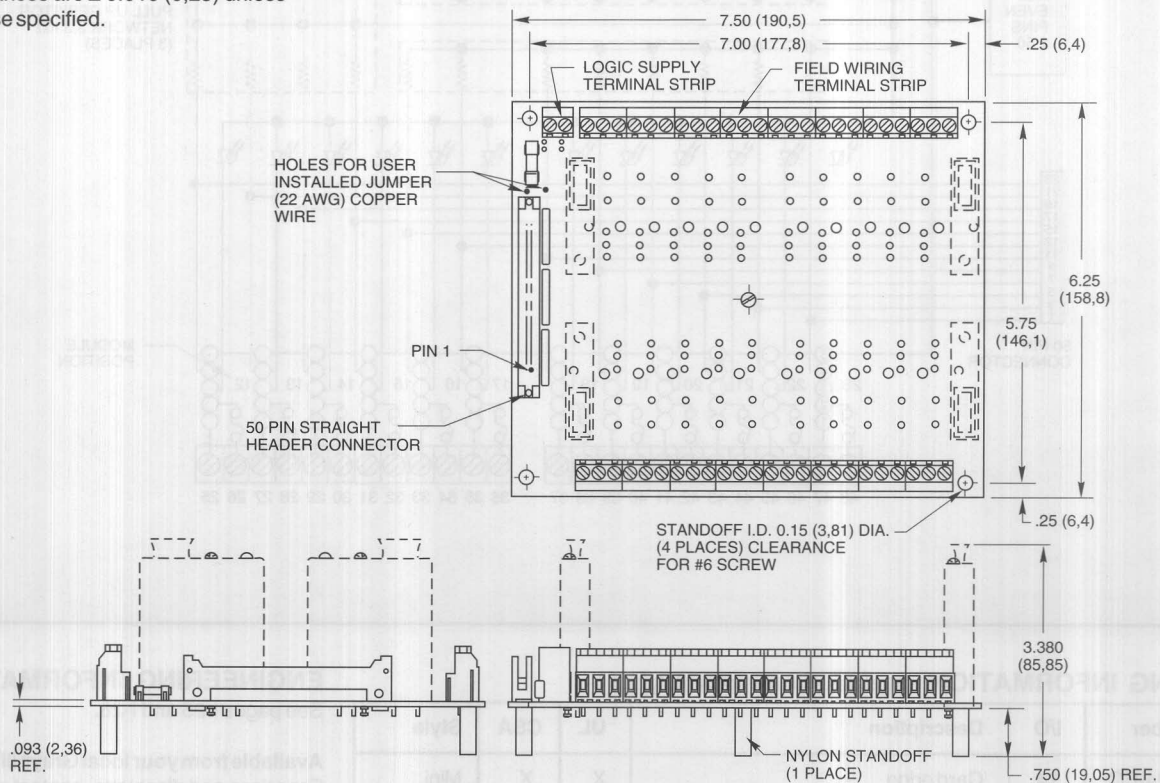


24 MODULE RACK-G5

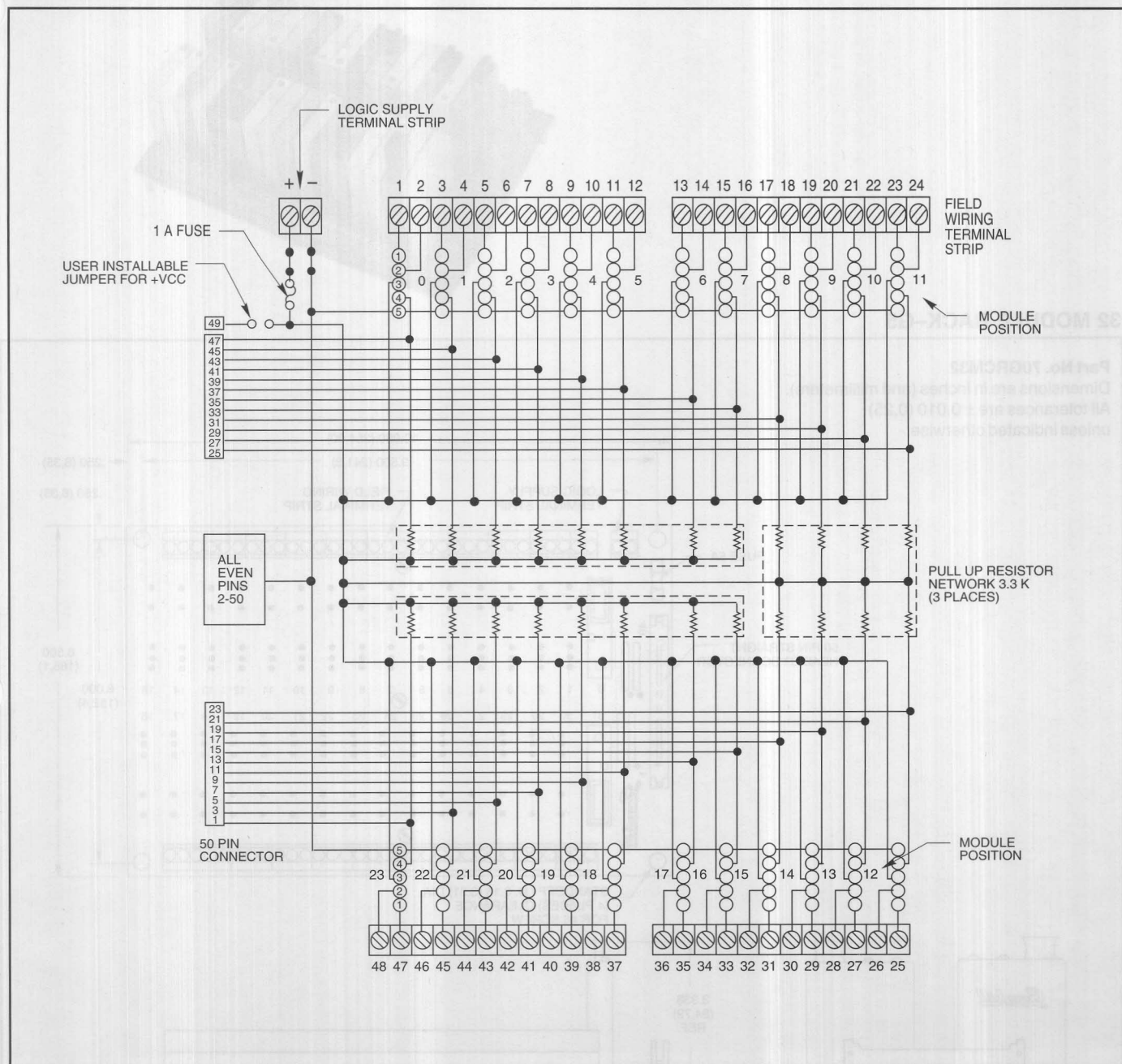
Part No. 70GRCQ24

Dimensions are shown in inches
(and millimeters).

All tolerances are ± 0.010 (0,25) unless
otherwise specified.



SCHEMATIC-Part No. 70GRCQ24



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70GRCQ24-HL	24	50 Pin header with ejector levers	X	X	G5

ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

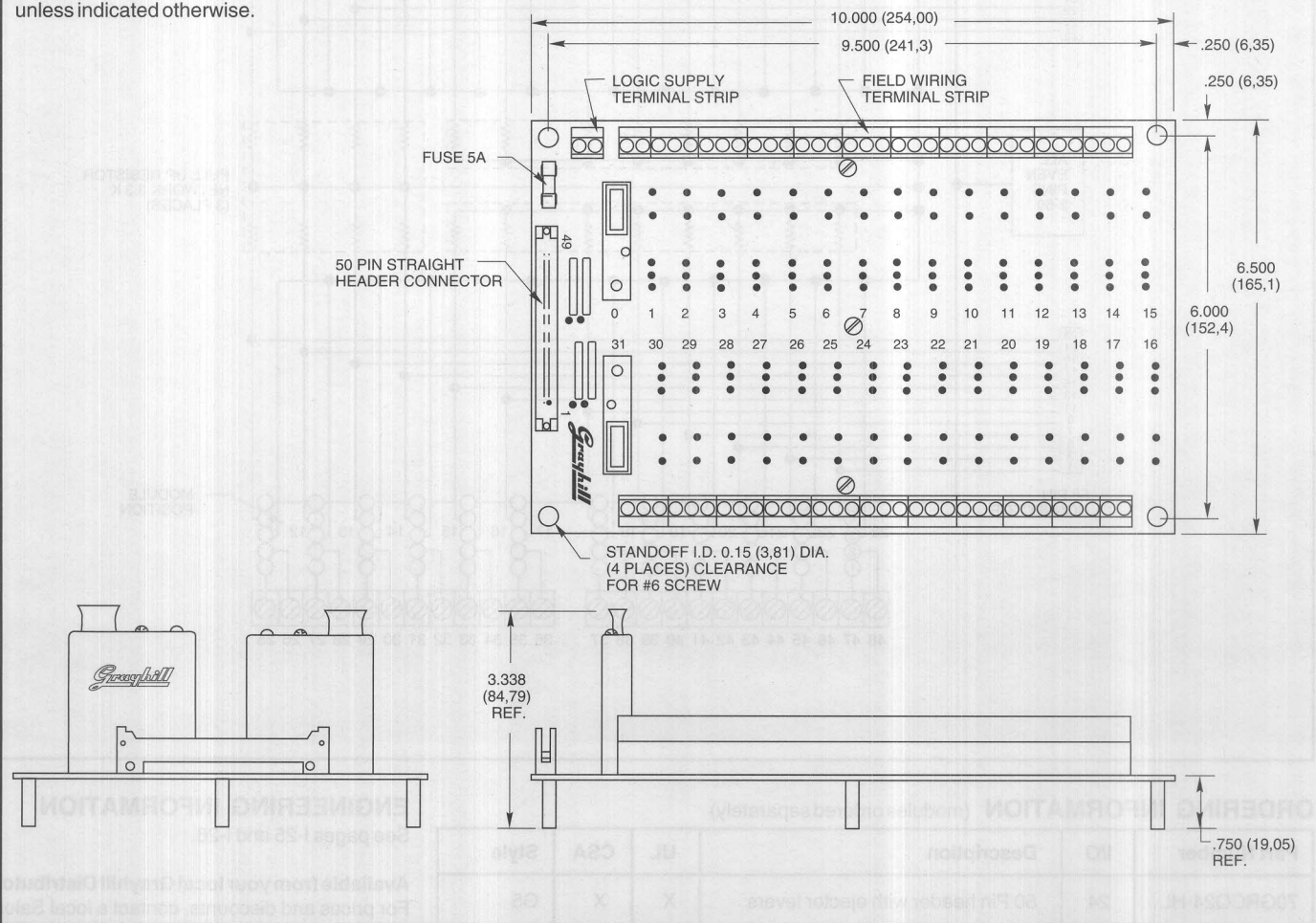
32 MODULE RACK-G5

Part No. 70GRCM32

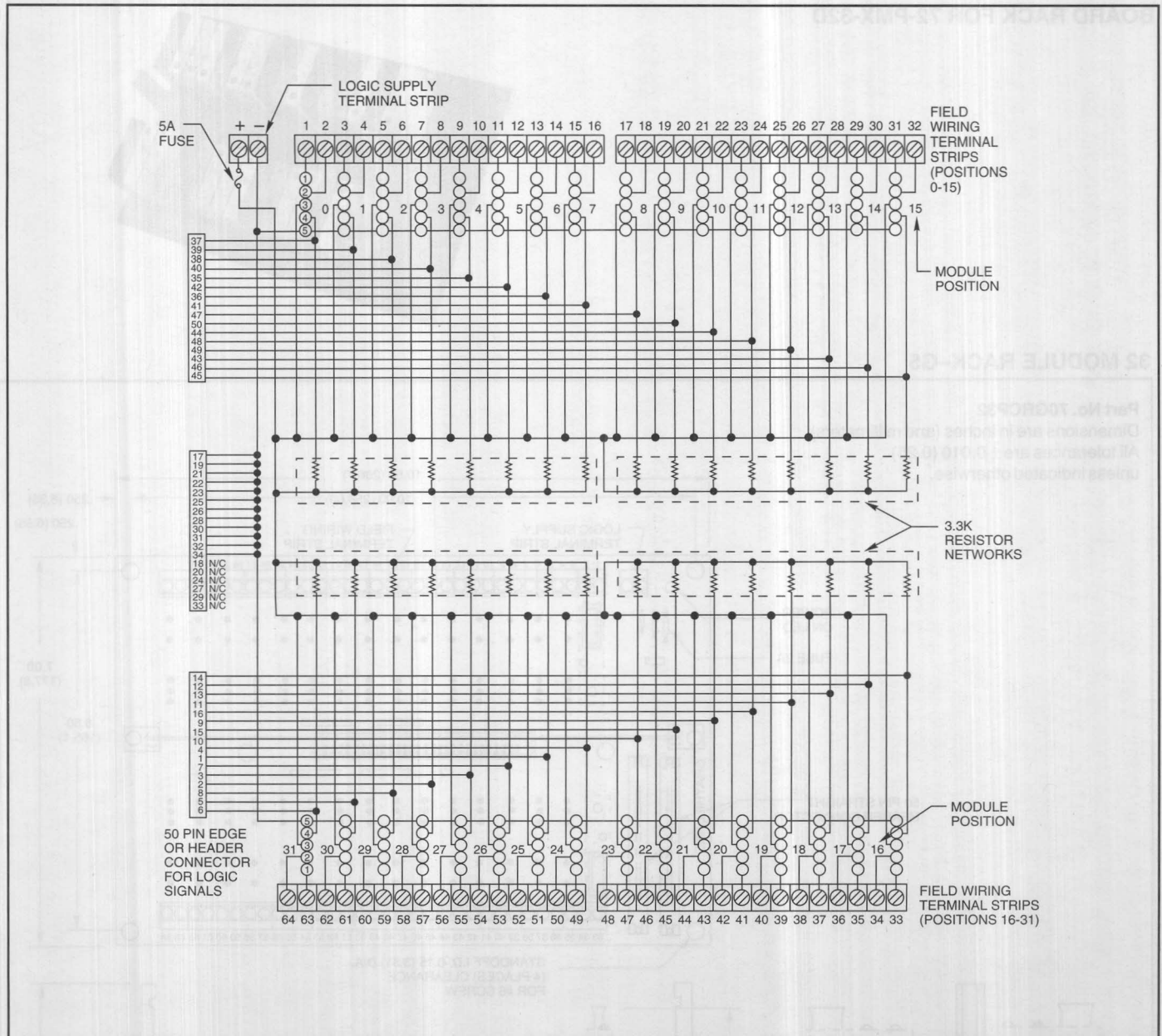
Dimensions are in inches (and millimeters).

All tolerances are ± 0.010 (0,25)

unless indicated otherwise.



SCHEMATIC—Part No. 70GRCM32



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70GRCM32-HL	32	50 Pin header with ejector levers	X	X	G5

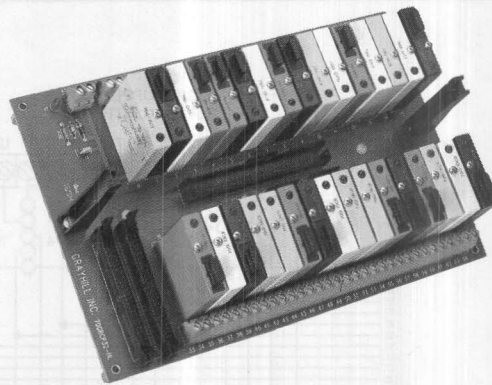
ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

MOUNTING RACKS

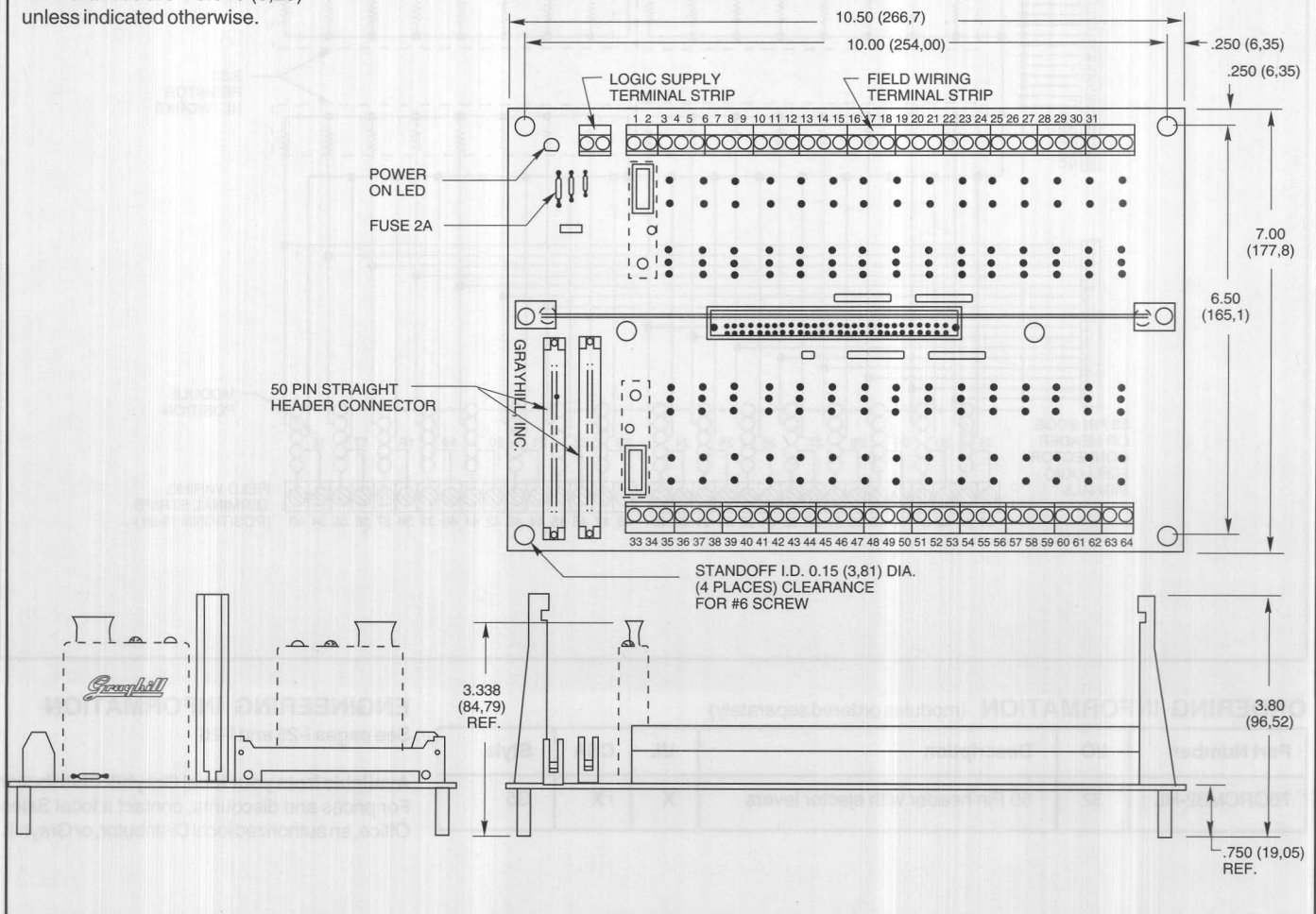
PARALLEL CONTROLLER BOARD RACK FOR 72-PMX-32D



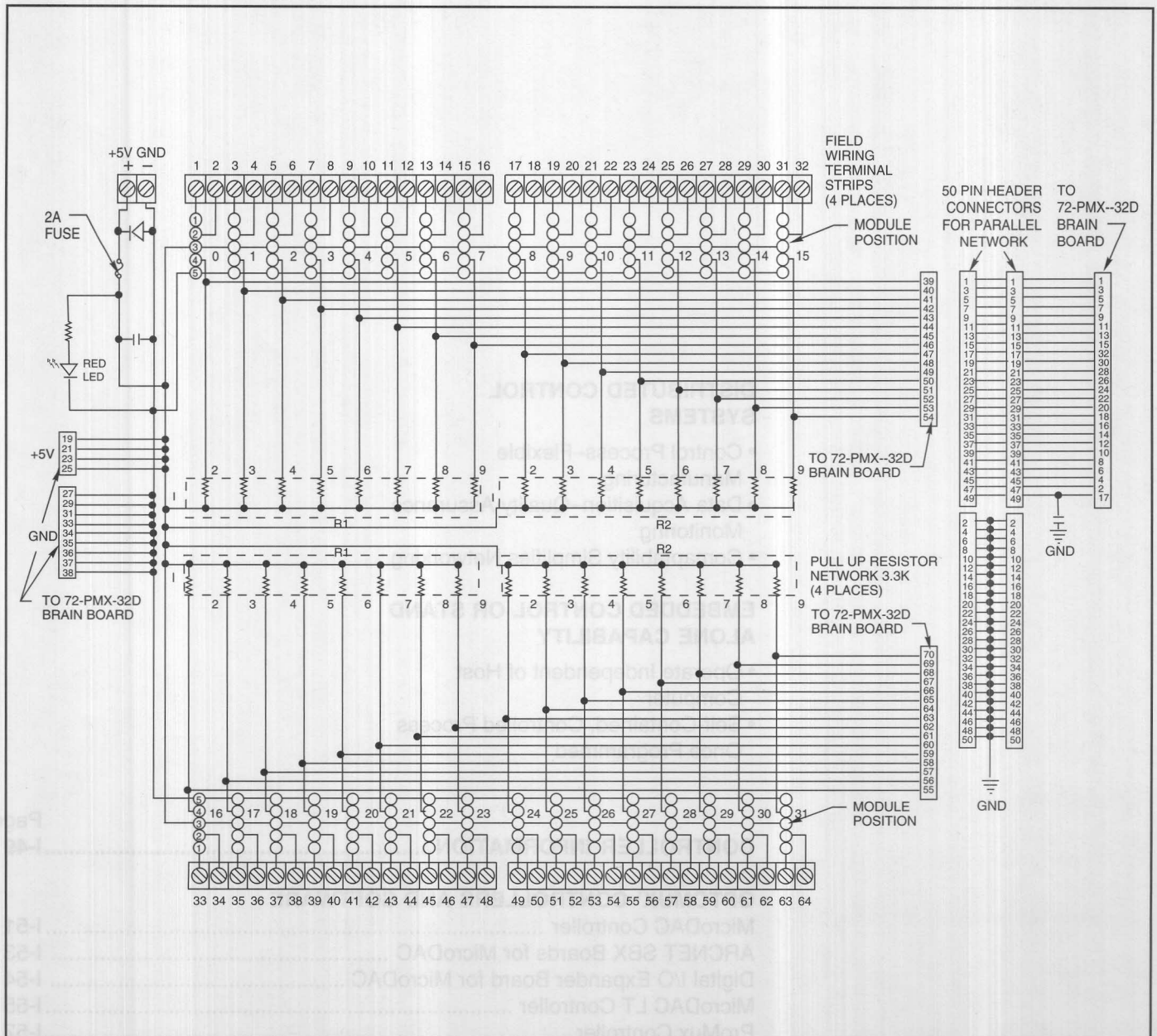
32 MODULE RACK-G5

Part No. 70GRCP32

Dimensions are in inches (and millimeters).
All tolerances are ± 0.010 (0,25)
unless indicated otherwise.



SCHEMATIC-Part No. 70GRCP32



ORDERING INFORMATION (modules ordered separately)

Part Number	I/O	Description	UL	CSA	Style
70GRCP32-HL	32	50 Pin header, long levers	X	X	G5

ENGINEERING INFORMATION

See pages I-25 and I-26.

Available from your local Grayhill Distributor
For prices and discounts, contact a local Sales Office, an authorized local Distributor, or Grayhill.

DISTRIBUTED CONTROL SYSTEMS

- Control Process—Flexible Manufacturing
- Data Acquisition—Quality Assurance Monitoring
- Comaptability Simplifies Networking

EMBEDDED CONTROL OR STAND ALONE CAPABILITY

- Operate Independent of Host Computer
- Self-Contained, Controlled Process Once Programmed

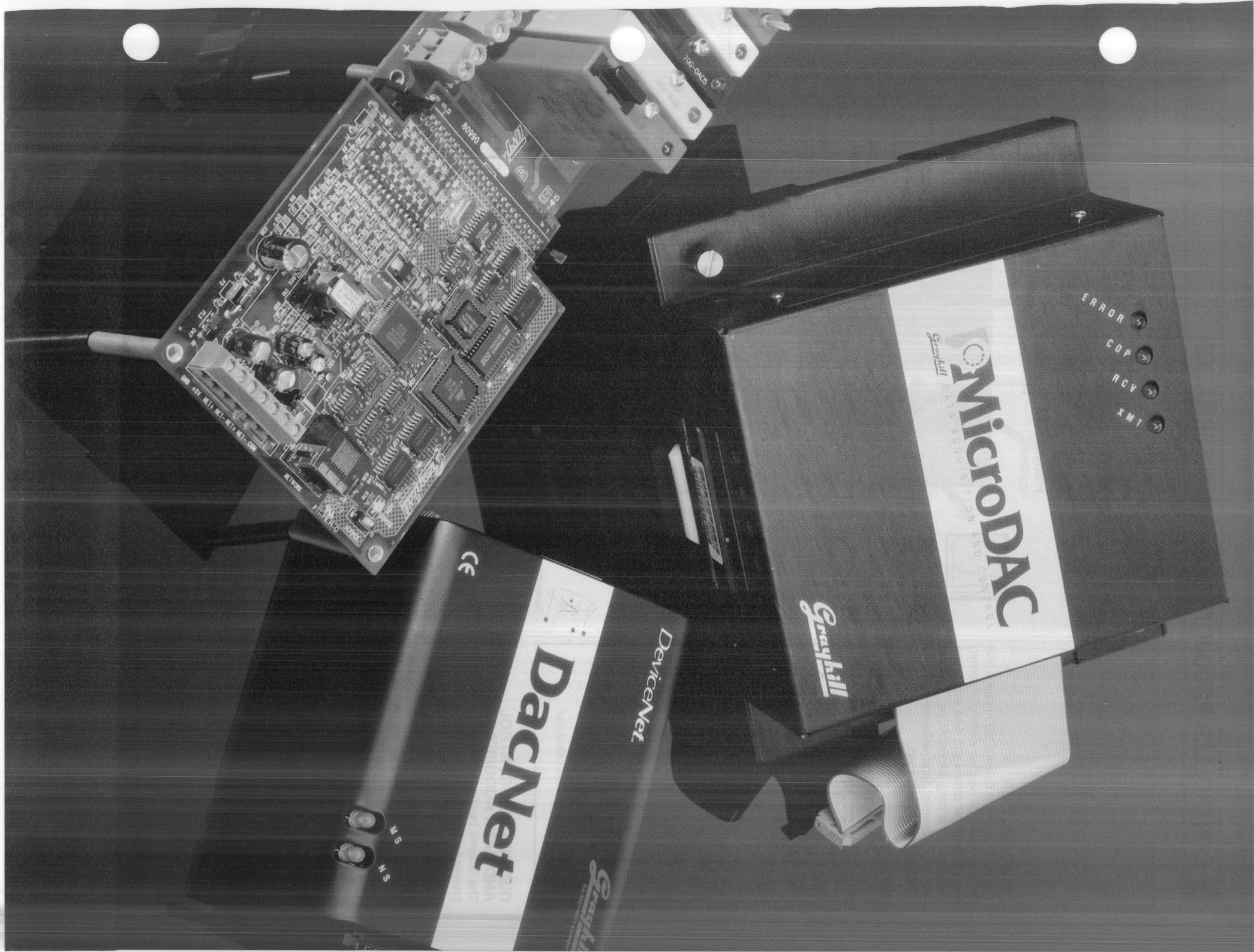
	Page
CONTROLLER INFORMATION	I-49

OPTOMUX¹ CONTROLLERS AND SOFTWARE

MicroDAC Controller	I-51
ARCNET SBX Boards for MicroDAC	I-53
Digital I/O Expander Board for MicroDAC	I-54
MicroDAC LT Controller	I-55
ProMux Controller	I-57
MicroDAC Dynamic Data Exchange (DDE) Server Software	I-59
MicroDAC Dynamic Link Library (DLL)	I-60
Paradym-31 Software	I-61
DacNet DeviceNet Controller	I-63
MicroLon LONWORKS Controller	I-65
Parallel Controllers	I-67
ISA Bus Adapter	I-69
RS-232 to RS-422/488 Communication Converters	I-70

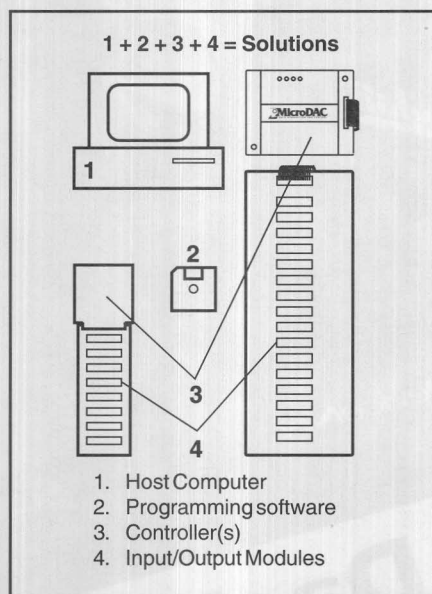
CONTROLLER ACCESSORIES	I-71
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¹Optomux is a trademark of Opto22.



INTRODUCTION

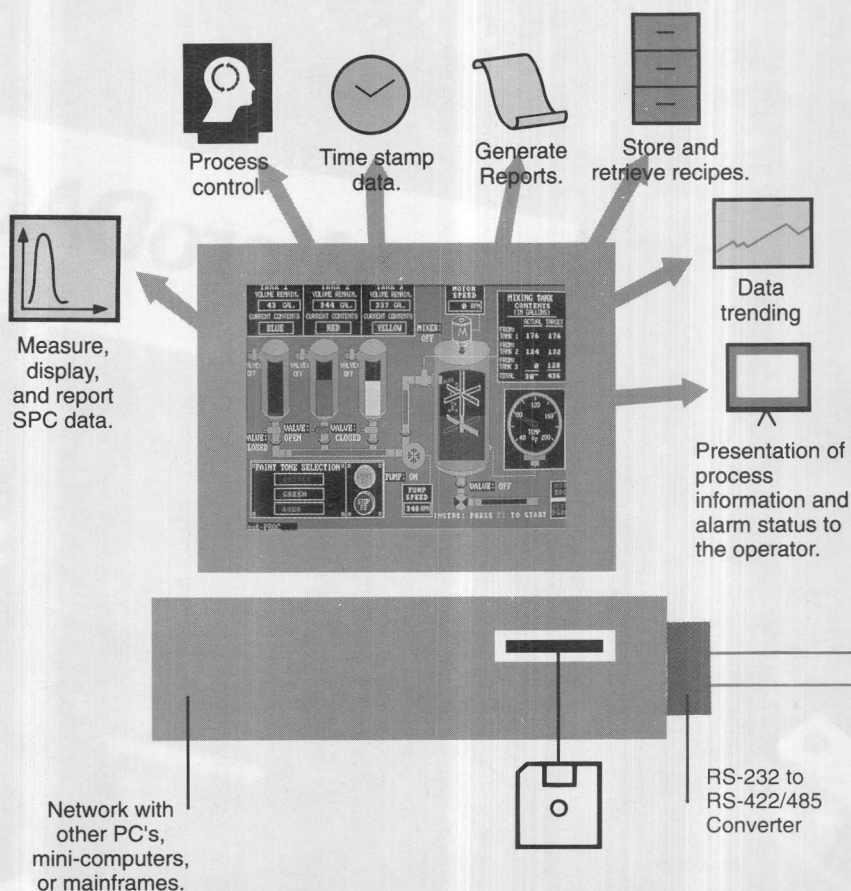
The wide variety of Grayhill I/O modules and racks provide a sound foundation for solving today's industrial control and data acquisition problems. By adding MicroDAC(s), ProMux® controller board(s), and software complete solutions can be developed.



DISTRIBUTED CONTROL AND DATA ACQUISITION

The Grayhill family of networkable controllers provide flexible and inexpensive solutions in PC control and data acquisition applications. With single point I/O, you buy only the quantity and type of I/O required to get the job done. Expensive signal conditioning devices and unused I/O go away. We offer a variety of network solutions for monitoring and controlling inputs and outputs over a wide area. Running long signal lines from the sensors and actuators to a centralized controller often results in signal integrity problems and costly installation and troubleshooting headaches. By installing controllers near the actual sensors and actuators, long sensor lines are eliminated. Network expansions and changes are easy to implement. The controllers are networked back to a network master, typically a PC, for supervisory functions and data analysis.

We offer controllers for three serial buses (Optomux¹, DeviceNet², and LonTalk³ protocols) and a parallel bus. The following pages provide details on each of the products. Our Application



Screen Graphics provided by Tele-Denken Resources, Inc.

Engineers will be happy to assist you in selecting the one that's right for your application.

OPTOMUX¹ PRODUCTS

Optomux is a defacto industry standard master/slave protocol which utilizes ASCII characters to represent commands from the PC to the remote controllers. MicroDAC, MicroDAC LT, and ProMux controllers use this protocol. MicroDACs are also capable of executing downloaded C programs for faster execution or for data storage.

A single ProMux® board can manage up to 24 digital I/O modules. MicroDACs are more powerful controllers that can handle a mix of up to 32 analog and digital signals. This adds data-acquisition, data logging, and proportional control capability to distributed I/O systems. Since they "speak the same language", MicroDACs and ProMux® boards can be networked together on the same serial link. Both have been designed to be compatible with current industry standard computing platforms, operating systems, and communications standards.

DEVICENET² PRODUCTS

DeviceNet is an open device network based on the proven Controller Area Network (CAN) standard. In addition to the communication lines, the DeviceNet bus also brings power to the remote controllers. Communication baud rates range from 125K baud to 500K baud at distances up to 1500 feet. Each DacNet controller can manage up to 32 I/O points in any mix of analog and digital modules.

The number of vendors providing hardware, software and development software for the DeviceNet totals over 200 from around the world. Most, including Grayhill, belong to the Open DeviceNet Vendors Association (ODVA).

LONWORKSTM PRODUCTS

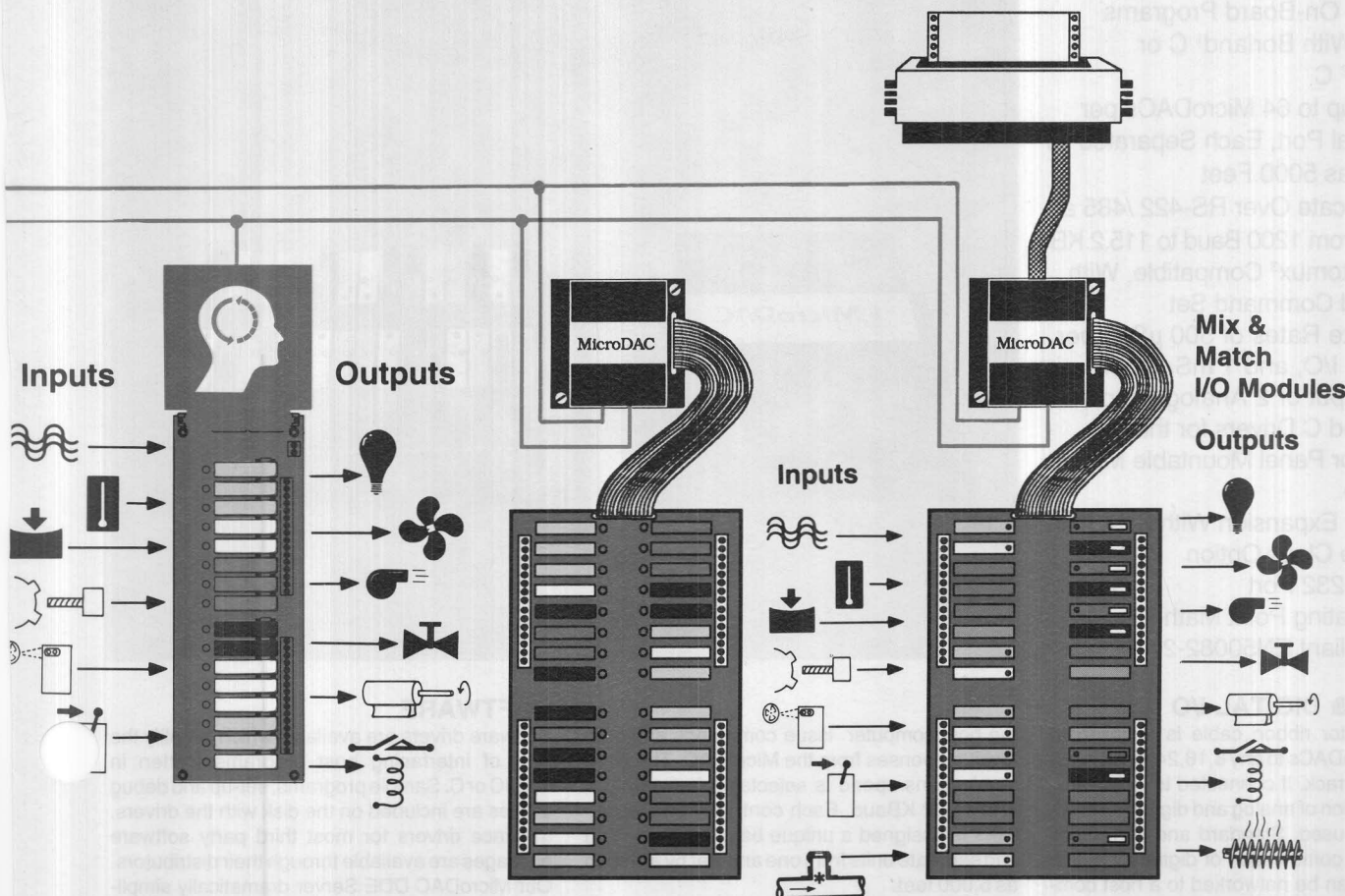
Our Microlon® controller combines the power of LonWorks™ technology with our analog and digital I/O modules. Microlon controllers may be distributed over great distances and networked to an industrial computer. Communications occur using a high speed (78 KB to 1.25 MB) peer-to-peer network and the LonTalk protocol. Each

Screen Graphics provided by Tele-Denken Resources, Inc.

1 Optomux is a trademark of Opto 22

2 DeviceNet is a registered trademark of ODVA

3 LonTalk is a registered trademark of Echelon



Microlon® contains the Neuron® chip which manages up to 8 analog or digital I/O and makes their status known on the network using Standard Network Variable Types (SNVTs). Up to 32, 385 Microlons or other LonTalk compatible products can be networked together. Grayhill is a LonMARK™ Partner with Echelon.

HIGH SPEED PARALLEL BUS

When sensors and loads are confined to a smaller area, or when execution speed is crucial, you may want to consider the PC Adapter Board or Parallel Controller Boards. These controllers are connected to the host computer using 50 pin flat ribbon cable. Response times are typically measured in microseconds, rather than milliseconds, which are common in distributed systems.

SUPPORT

Our team of Application Engineers and our Customer Service Department are at your disposal. For local support, contact any of our Industrial Distributors. All of these trained product specialists can help assure that the parts ordered

are suitable and complete for your application. Literature and catalogs are free for the asking.

After the sale, assistance is available by calling our Technical Support Hotline:

1-800-426-4383 (USA)
1-800-535-6107 (Canada)

The latest software revisions, as well as, numerous sample and utility programs are accessible via modem on the Control Products BBS (9600 baud, 8 bits/char.; 1 stop bit; no parity):

708-354-0844

or on-line at:

<http://www.grayhill.com>

APPLICATIONS

Grayhill controllers are field proven and presently hard at work . . .

- Supplying fresh water to cities
- Processing and packaging food
- Monitoring power plant alarms
- Managing energy usage
- Controlling manufacturing processes
- Testing aircraft brakes
- Handling material flow in warehouses
- Formulating and mixing house paint

Off-the-shelf software packages from several software companies are used in a number of these applications. In addition to making control decisions, these programs can record data for trending, time stamp data, generate reports, store and retrieve recipes, and display process information and alarm status to the operators as depicted above.

Expanded Command Set

- I/O Update Rates of 500 μ Sec per 32 Digital I/O, and 1 mSec per Analog Input or 2 Analog Outputs
- BASIC and C Drivers for the PC
- DIN Rail or Panel Mountable Metal Enclosure
- Hardware Expansion With SBX Port
- Real Time Clock Option
- Local RS-232 Port
- 64 Bit Floating Point Math
- CE Compliant EN50082-2

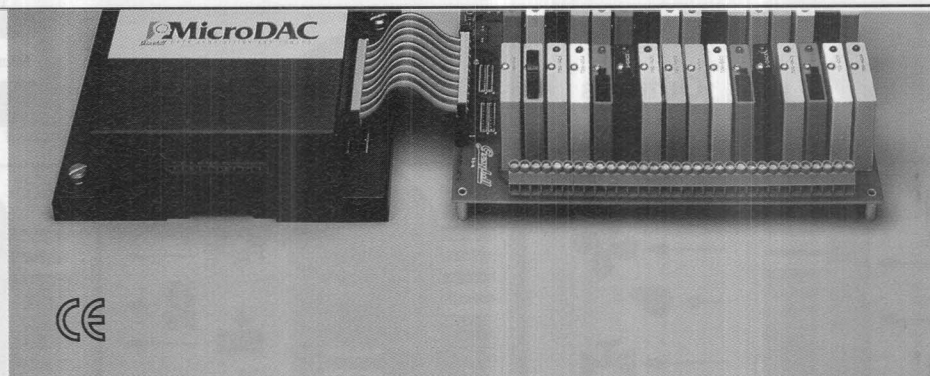
ANALOG & DIGITAL I/O

A 50 conductor ribbon cable is supplied to connect MicroDACs to any 8, 16, 24, or 32 module mounting rack. If connected to a G5 rack, any combination of analog and digital I/O modules may be used. Standard and Mini racks permit only a combination of digital modules. MicroDACs can be networked to a host computer which runs programs that monitor the input signals and control the outputs. In addition to simple ON/OFF instructions, commands are included which permit you to:

- Sample analog signals at 1 mSec per input
- Flag values above or below prescribed levels
- Capture min/max values
- Calculate the average input signal levels
- Provide linearized thermocouple and RTD temperature values
- Determine the width of input pulses
- Count pulses at frequencies up to 1000Hz
- Detect rising or falling edges
- Latch momentary input events
- Set the level of analog outputs
- Generate square, sawtooth, triangular, or ramp waveforms
- Provide delayed-on or delayed-off outputs

COMMUNICATIONS

The host computer and MicroDAC(s) communicate serially over one or two pair of twisted wires per RS-422/485 in either a multi-drop or repeat configuration. They use Optomux³ ASCII format to code the command and the response messages. Application programs running on



the host computer issue commands and then await responses from the MicroDAC. The communications speed is selectable between 1.2 and 115.2 Kbaud. Each controller on the network is assigned a unique base address. You can separate units from one another by as much as 5,000 feet.¹

EMBEDDED CONTROL PROGRAMS

By specifying MicroDAC(s) with the optional 64Kb of flash memory, you can develop and download C language programs to any of the networked controllers.

Even while an Embedded Control Program (ECP) is running on MicroDAC, any Optomux³ command it receives from the host will be processed as usual, which allows you to delegate some or all of the control and data acquisition responsibility from the host computer. This reduces communications time and improves system response.

For embedded or stand-alone applications, downloaded ECP routines can be initiated on power-up. Where redundant control or process shut-down procedures are vital, ECP initiation can be tied to the communications watchdog timer. In the event the host computer goes off line, the ECP automatically begins executing.

Libraries and the appropriate download utility are included with the ECP Programmers Manual.

SOFTWARE

Software drivers are available which simplify the task of interfacing host programs written in BASIC or C. Sample programs, set-up and debug utilities are included on the disk with the drivers. Interface drivers for most third party software packages are available through their distributors. Our MicroDAC DDE Server dramatically simplifies data sharing between MicroDACs and Windows 3.1 applications, such as Microsoft² EXCEL (see Optomux Software). Our DLL will assist you in building custom Windows Man-Machine Interfaces using Visual Basic, Visual C/C++, or Borland compilers.

OTHER FEATURES/OPTIONS

The RS-232 serial port provides a connection for remote RS-232 devices. You can use this port to read information from input devices such as bar code readers or keyboards or to write information to output devices such as operator interfaces, intelligent displays or printers.

The optional real time clock permits ECP routines to be executed based on date or time of day. It also allows data that is collected to be time stamped and stored in battery backed RAM memory.

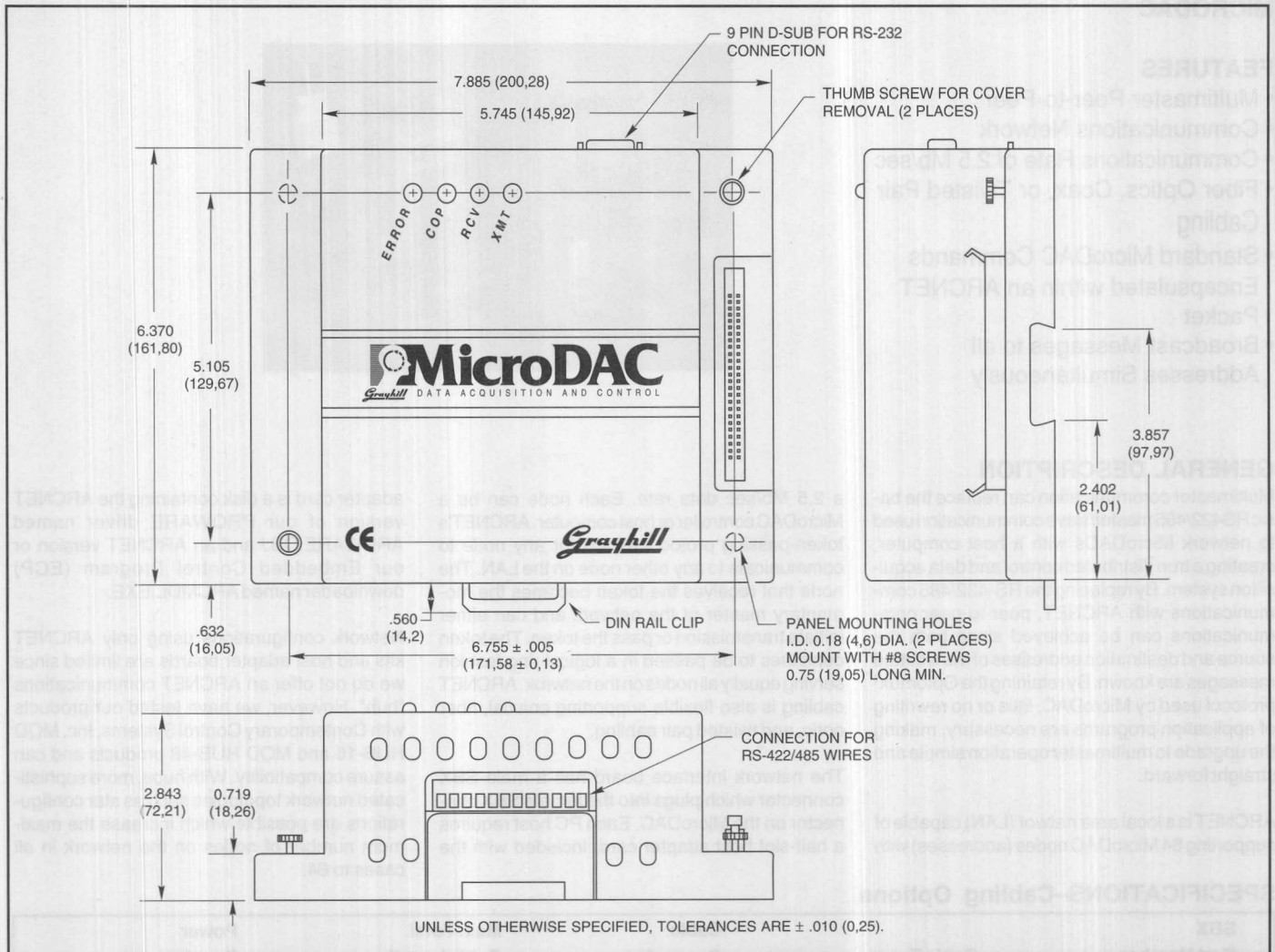
For more sophisticated applications, Grayhill or third party SBX boards can be installed under the MicroDAC cover (see MicroDAC plug-in cards). The ARCNET kits can be used to enhance the communications between MicroDACs by adding peer-to-peer capability and improving response time. The I/O count per MicroDAC can be increased by 48 digital I/O with the addition of the I/O expansion SBX board.

¹ Borland is a trademark of Borland International Inc.

² Microsoft is a trademark of Microsoft Corp.

³ Optomux is a trademark of Opto 22.

DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Power Supply: 4.75 to 5.25 Vdc
Supply Current (less modules): 1 A maximum
Operating Temperature: 0 to 60°C
Humidity: 95% non condensing
Housing Material: Anodized Aluminum
Microprocessor: V25 @ 10 MHz

Connections

RS-422/485: 12 position terminal block
RS-232 (DCE or DTE): 9 pin D-Sub (male)
SBX: 36 pin dual row (female)
Rack: 50-pin male header

Serial Data

Format: 10 Bit ASCII: 1 Start, 1 Stop, 8 Data
Integrity: Message Checksum or 4 Pass + CS

Range of Network

Multidrop: Up to 5,000 feet total length, with 64 MicroDACs maximum.
Repeat: Up to 5,000 feet between each node, with 64 MicroDACs maximum.

ORDERING INFORMATION

Part Number	Description
MicroDAC Controllers	
72-MDC-32D	Digital only MicroDAC with RS-232 and SBX ports
72-MDC-32AD	Analog/Digital MicroDAC with RS-232 and SBX ports
72-MDC-32DC	Digital only MicroDAC with RS-232 and SBX ports, 64K batt. backed RAM, 64K flash for C ECP storage, and real time clock.
72-MDC-32ADC	Analog/Digital MicroDAC with RS-232 and SBX ports, 64K batt. backed RAM, 64K flash for C ECP storage, and real time clock.
72-MDC-32ADP	Analog/Digital MicroDAC with RS-232 and SBX ports, 64K batt. backed RAM, 64K flash for C ECP storage, and real time clock, compatible with Paradym-31 software.
72-MDC-EVK	MicroDAC evaluation kit. Includes 72-MDC-32ADC, 24 position rack, mix of analog and digital I/O modules, 72-CNV-1, cables and manuals.
MicroDAC User's Manuals	
72-UMM	Introduction to MicroDAC
72-UMM-D	Driver development and protocol definition. Includes driver source code
72-UMM-DDE	MicroDAC DDE Server
72-UMM-DLL	MicroDAC DLL
72-UMM-E	C language ECP manual with libraries
72-UMM-H	Programmers manual with Basic and C host drivers & examples
72-UMM-IL	Hardware installation and set-up. Includes set-up and debug programs.

Available from your local authorized Grayhill Distributor.

For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

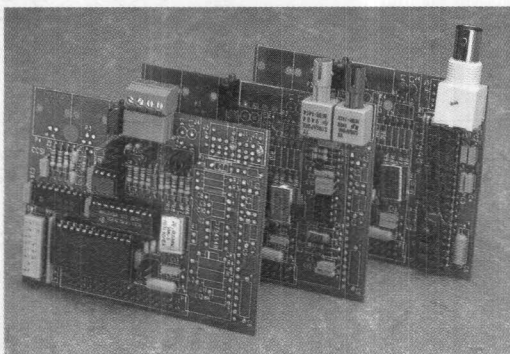


OPTOMUX CONTROLLERS—MICRODAC PLUG-IN CARDS

ARCNET® SBX BOARDS FOR MICRODAC

FEATURES

- Multimaster Peer-to-Peer
- Communications Network
- Communications Rate of 2.5 Mb/sec
- Fiber Optics, Coax, or Twisted Pair Cabling
- Standard MicroDAC Commands Encapsulated within an ARCNET Packet
- Broadcast Messages to all Addresses Simultaneously



GENERAL DESCRIPTION

Multimaster communication can replace the basic RS422/485 master/slave communication used to network MicroDACs with a host computer, creating a true distributed control and data acquisition system. By replacing the RS-422/485 communications with ARCNET, peer-to-peer communications can be achieved since both the source and destination addresses of transmitted messages are known. By retaining the Optomux¹ protocol used by MicroDAC, little or no rewriting of application programs are necessary, making the upgrade to multimaster operation simple and straight forward.

ARCNET is a local area network (LAN) capable of supporting 64 MicroDAC nodes (addresses) with

a 2.5 Mb/sec data rate. Each node can be a MicroDAC controller or host computer. ARCNET's token-passing protocol allows for any node to communicate to any other node on the LAN. The node that receives the token becomes the momentary master of the network and can either initiate transmission or pass the token. The token continues to be passed in a logical ring fashion serving equally all nodes on the network. ARCNET cabling is also flexible supporting coaxial, fiber optic, and twisted pair cabling.

The network interface board has a male SBX connector which plugs into the female SBX connector on the MicroDAC. Each PC host requires a half-slot host adapter card. Included with the

adapter card is a disk containing the ARCNET version of our PROWARE driver named ARCWARE.OBJ and an ARCNET version of our Embedded Control Program (ECP) downloader named ARCMDL.EXE.

Network configurations using only ARCNET kits and host adapter boards are limited since we do not offer an ARCNET communications "hub". However, we have tested our products with Contemporary Control Systems, Inc. MOD HUB-16 and MOD HUB-48 products and can assure compatibility. With hubs, more sophisticated network topologies such as star configurations are possible which increase the maximum number of nodes on the network in all cases to 64.

SPECIFICATIONS—Cabling Options

SBX Part Number	Cable Type	Cable Connectors	Max. Total Cable Length	Power Requirements
72-SBX-ARCCXB	Coaxial RG-62/u (Belden 86262)	BNC	1,000 ft (310 m)	+5 Vdc @ 200 mA -12Vdc @ 50 mA*
72-SBX-ARCFO	Fiber 50/125	ST	3,000 ft (915 m)	+5 Vdc @ 300mA
	Fiber 62.5/125	ST	6,000 ft (1,825 m)	
	Fiber 100/140	ST	9,000 ft (2,275 m)	
72-SBX-ARC485	Twisted Pair (Belden 9841)	Screw Terminal	900 ft (274 m)	+5 Vdc @ 200 mA

* The -12V connection is made to test point TP2 adjacent to the SBX connector on MicroDAC.

SPECIFICATIONS—General

Operating Temperature: 0 to 60°C, 95% relative humidity, non-condensing
Storage Temperature Range: -40 to 85°C
Dimensions: 2.85" (72,4) x 3.7" (94,0) x 0.5" (12,7) for the SBX boards; 1/2 Card Slot for the Host Adapter Boards
Communications: Deterministic 2.5 Mb ARCNET token-passing

ORDERING INFORMATION

Part Number	Description
72-PCCXB-ARC	IBM PC host adapter board with coaxial cable connector MicroDAC ARCNET kit for coaxial cable with installation guide ARCNET coaxial cable 93Ω bus terminator
72-SBX-ARCCXB	
72-TERM93	
72-PCFO-ARC	IBM PC Host Adapter Board with Fiber Optic Connector MicroDAC ARCNET Kit for Fiber Optic Cable with Installation Guide
72-SBX-ARCFO	
72-PC485-ARC	IBM PC host adapter board with twisted pair connector MicroDAC ARCNET kit for twisted pair cable with installation guide MicroDAC ARCNET kit brochure
72-SBX-ARC485	
Bulletin #638	

ARCNET is a registered trademark of the Datapoint Corporation.

Available from your local Grayhill Industrial Distributors.

For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

DIGITAL I/O EXPANDER BOARD FOR MICRODAC

FEATURES

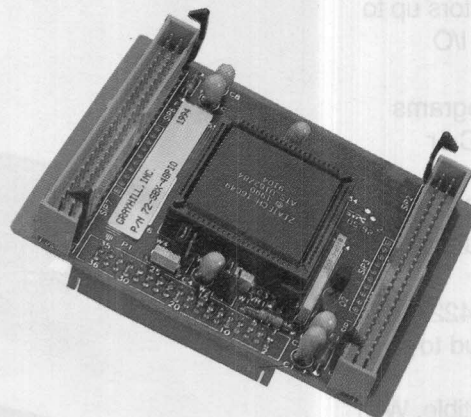
- Ribbon Cable to Two Additional 24 Position Racks
- Increase I/O per MicroDAC to 80

GENERAL DESCRIPTION

In applications where there are high concentrations of I/O at some of the locations, this board decreases the number of MicroDACs required by increasing the number of I/O managed by each MicroDAC.

SPECIFICATIONS-General

Operating Temperature: 0 to 60°C,
95% relative humidity, non-condensing
Storage Temperature Range: -40 to 85°C
Dimensions: 2.85" (72,4) x 3.7" (94,0)
x 1.3" (33,0)



The 48 PIO board plugs into the SBX connector on MicroDACs. The board fits under the aluminum cover and the ribbon cables are routed through the knock panel on the cover to additional racks of digital I/O. The racks can be 8, 16, or 24 position racks located within 6 feet of the MicroDAC. An

ECP program executing on the MicroDAC can be used to control or monitor the status of the remote I/O, or all 48 points of digital I/O can be accessed with extended ProWare commands over the network.

ORDERING INFORMATION

Part Number	Description
72-SBX-48PIO	48 I/O SBX expander board for MicroDAC

Available from your local Grayhill Industrial Distributors.

For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

- 100% Optomux³ Compatible, With Expanded Command Set
- I/O Update Rates of 500 μ Sec per 32 Digital I/O, and 1 mSec per Analog Input or 2 Analog Outputs
- 64 Bit Floating Point Math
- CE Certified to EMC Directive
- DIN Rail or Panel Mountable Metal Enclosure Optional
- CE Compliant EN50082-2⁴



GENERAL DESCRIPTION

MicroDAC LT is a low cost version of MicroDAC for customers who don't need all of the features of MicroDAC. Missing are the battery back-up for the RAM memory, real-time clock, RS-232, and SBX ports. The DIN Rail Mountable metal enclosure is optional. ECP routines written for MicroDAC can be easily transferred to MicroDAC LT and vice versa. By combining MicroDAC, MicroDAC LT and ProMux the cost/performance of a distributed control or data acquisition network can be optimized.

ANALOG & DIGITAL I/O

MicroDAC LT connects directly to any 8, 16, 24, or 32 module mounting rack. If connected to a G5 rack, any combination of analog and digital I/O modules may be used. Standard and Mini racks permit only a combination of digital modules. MicroDAC LTs can be networked to a host computer which runs programs that monitor the input signals and control the outputs. In addition to simple ON/OFF instructions, commands are included which permit you to:

- Sample analog signals at 1 mSec per input
- Flag values above or below prescribed levels
- Capture min/max values
- Calculate the average input signal levels
- Provide linearized thermocouple and RTD temperature values
- Determine the width of input pulses
- Count pulses at frequencies up to 1000Hz
- Detect rising or falling edges
- Latch momentary input events

- Set the level of analog outputs
- Generate square, sawtooth, triangular, or ramp waveforms
- Provide delayed-on or delayed-off outputs

COMMUNICATIONS

The host computer and MicroDAC LT(s) communicate serially over one or two pair of twisted wires per RS-422/485 in a multi-drop configuration. They use Optomux³ ASCII format to code the command and the response messages. Application programs running on the host computer issue commands and then await responses from the MicroDAC. The communications speed is selectable between 1.2 and 115.2 Kbaud. Each controller on the network is assigned a unique base address. The entire network can span 4000 feet.

EMBEDDED CONTROL PROGRAMS

By specifying MicroDAC LT(s) with the optional 64Kb of flash memory, you can develop and download C language programs to any of the networked controllers.

Even while an Embedded Control Program (ECP) is running on MicroDAC LT, any Optomux³ command it receives from the host will be processed as usual, which allows you to delegate some or all of the control and data acquisition responsibility from the host computer. This reduces communications time and improves system response.

For embedded or stand-alone applications,

downloaded ECP routines can be initiated on power-up. Where redundant control or process shut-down procedures are vital, ECP initiation can be tied to the communications watchdog timer. In the event the host computer goes off line, the ECP automatically begins executing.

Libraries and the appropriate download utility are included with the ECP Programmers Manual.

SOFTWARE

Software drivers are available which simplify the task of interfacing host programs written in BASIC or C to the MicroDAC network. Sample programs, set-up and debug utilities are included on the disk with the drivers. Interface drivers for most third party software packages are available through their distributors. Our MicroDAC DDE Server dramatically simplifies data sharing between MicroDACs and Windows 3.1 applications, such as Microsoft² EXCEL (see Controller Software). Our DLL will assist you in building custom Windows Man-Machine Interfaces using Visual Basic, Visual C/C++, or Borland compilers.

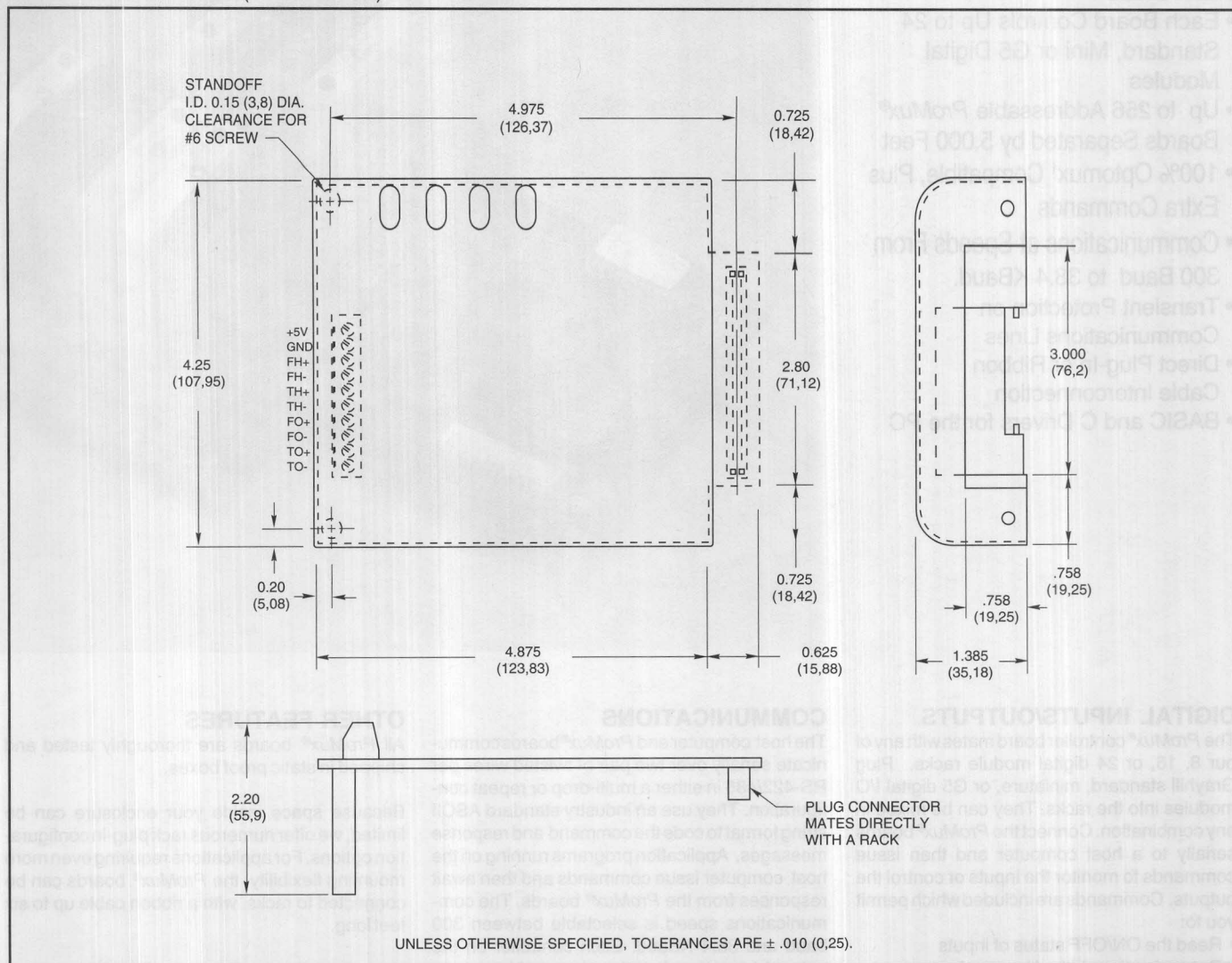
¹ Borland is a trademark of Borland International Inc.

² Microsoft is a trademark of Microsoft Corp.

³ Optomux is a trademark of Opto 22.

⁴ With optional enclosure.

DIMENSIONS In inches (and millimeters)



SPECIFICATIONS

Power Supply: 4.75 to 5.25 Vdc
Supply Current (less modules): 300 mA
Operating Temperature: 0 to 70°C
Humidity: 95% non condensing
Microprocessor: V25 @ 10 MHz
Housing Material: Painted steel

Connections

RS-422/485: 10 position terminal block
Rack: 50-pin female plug

Serial Data

Format: 10 Bit ASCII: 1 Start, 1 Stop, 8 Data
Integrity: Message Checksum or 4 Pass + CS

Range of Network

Multidrop: Up to 4,000 feet total length, with 64 MicroDAC LTs maximum.

ORDERING INFORMATION

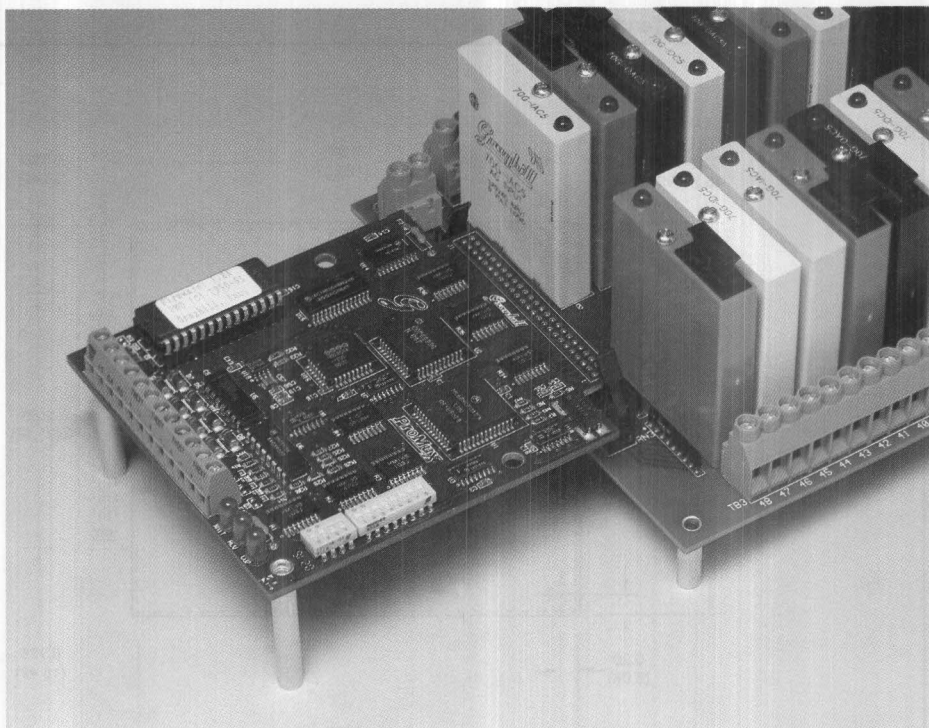
Part Number	Description
MicroDAC LT Controllers	
72-MDL-32AD	Analog/Digital MicroDAC LT
72-MDLE-32AD	Analog/digital MicroDAC LT with metal enclosure
72-MDL-32ADC	Analog/Digital with 64 K flash for C ECP storage
72-MDLE-32ADC	Analog/digital MicroDAC LT with 64K flash for C ECP storage and metal enclosure
72-MDL-32ADP	Analog/Digital with 64 K flash for C ECP storage, compatible with Paradym-31 software
72-MDLE-32ADP	Analog/digital MicroDAC LT with 64K flash for C ECP storage and metal enclosure, compatible with Paradym-31 software
MicroDAC LT User's Manuals	
72-UMM	Introduction to MicroDAC
72-UMM-D	Driver development and protocol definition. Includes driver source code
72-UMM-DDE	MicroDAC DDE Server
72-UMM-DLL	MicroDAC DLL
72-UMM-E	C language ECP manual with libraries
72-UMM-H	Programmers manual with Basic and C host drivers & examples
72-UMM-IL	Hardware installation and set-up. Includes set-up and debug programs

Available from your local authorized Grayhill Distributor.

For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

FEATURES

- Each Board Controls Up to 24 Standard, Mini or G5 Digital Modules
- Up to 256 Addressable *ProMux*[®] Boards Separated by 5,000 Feet
- 100% Optomux¹ Compatible, Plus Extra Commands
- Communications at Speeds From 300 Baud to 38.4 Kbaud.
- Transient Protection on Communications Lines
- Direct Plug-In or Ribbon Cable Interconnection
- BASIC and C Drivers for the PC



DIGITAL INPUTS/OUTPUTS

The *ProMux*[®] controller board mates with any of our 8, 16, or 24 digital module racks. Plug Grayhill standard, miniature, or G5 digital I/O modules into the racks. They can be mixed in any combination. Connect the *ProMux*[®] boards serially to a host computer and then issue commands to monitor the inputs or control the outputs. Commands are included which permit you to:

- Read the ON/OFF status of inputs
- Determine the width of input pulses
- Count pulses at frequencies up to 400Hz
- Detect rising or falling edges
- Latch momentary input events
- Turn outputs On or OFF individually or in groups
- Pulse-width modulate outputs
- Provide delayed-on or delayed-off outputs
- Generate pulses or squarewaves

COMMUNICATIONS

The host computer and *ProMux*[®] boards communicate serially over two pair of twisted wires per RS-422/485 in either a multi-drop or repeat configuration. They use an industry standard ASCII string format to code the command and response messages. Application programs running on the host computer issue commands and then await responses from the *ProMux*[®] boards. The communications speed is selectable between 300 baud and 38.4 Kbaud. Each controller on the network is assigned a unique base address from 0 to 255. You can separate boards from one another by as much as 5,000 feet.

SOFTWARE

Software drivers are available which simplify the task of interfacing programs written in BASIC or C to the *ProMux*[®] network. Sample programs and the set-up and debug utilities are included on the disk with the drivers. Interface drivers for most third party software packages are available through their distributors.

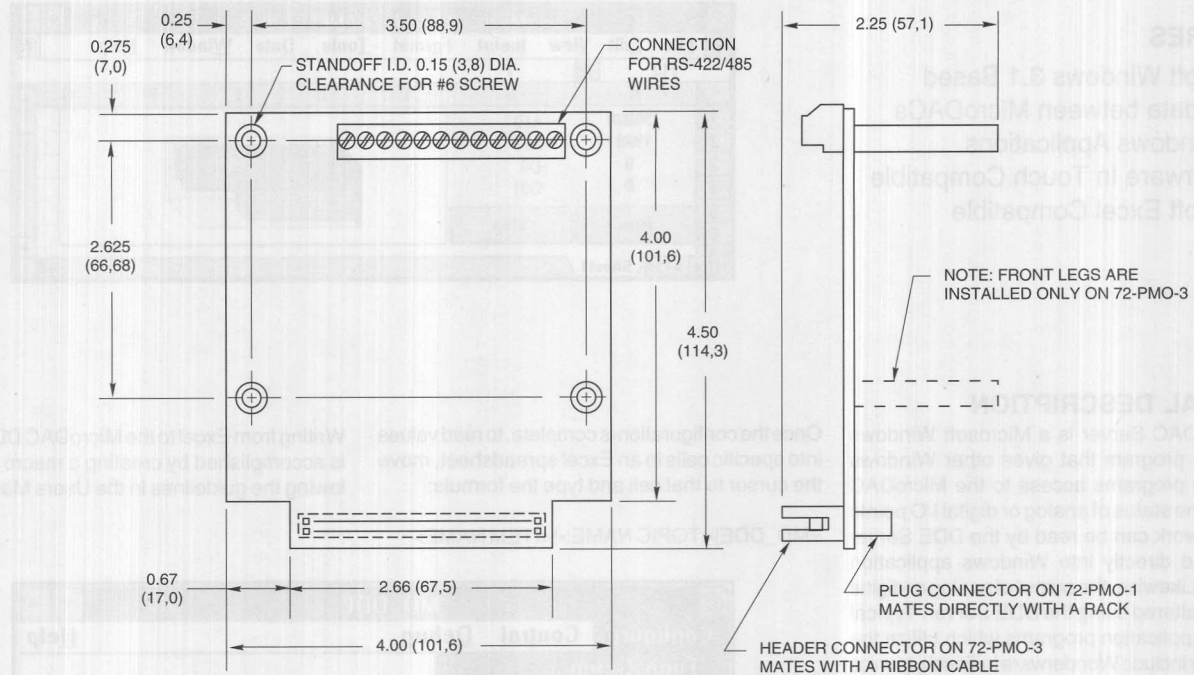
OTHER FEATURES

All *ProMux*[®] boards are thoroughly tested and shipped in static proof boxes.

Because space inside your enclosure can be limited, we offer numerous rack plug-in configuration options. For applications requiring even more mounting flexibility, the *ProMux*[®] boards can be connected to racks with a ribbon cable up to six feet long.

If you do not have an RS-422 or RS-485 serial port on your PC, we offer an RS-232 to RS-422 converter. 72-CNV-1, 72-CNV-2 or 72-CNV-3 converter will plug in directly to the 25-pin RS-232 port of your computer.

DIMENSIONS In inches (and millimeters)



UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE ± 0.010 (0,25).

SPECIFICATIONS

Supply Voltage: 4.5 to 5.5 Vdc
Supply Current (less modules): 0.1 to 0.5 A
Operating Temperature: 0° to 70° C
Humidity: 95% non condensating
Microprocessor: 68HCII @ 7.4 MHz

Connections

RS-422/485: 12 position terminal block
Rack: 50-pin female plug connector or 50-pin male header connector

Serial Data

Format: 10 Bit ASCII: 1 Start, 1 Stop, 8 Data
Integrity: Message Checksum or 4 Pass + CS

Range of Network

Multidrop: Up to 5,000 feet total length, with 75 *ProMux*[®] boards maximum
Repeat: Up to 5,000 feet between boards, with 256 *ProMux*[®] boards maximum

ORDERING INFORMATION

Part Number	Description
72-PMO-1	Plug connector for direct rack connection
72-PMO-3	Header connector for ribbon cable to rack connection
<i>ProMux</i> [®] User's Manuals	
72-UMO	With no software, for evaluating boards for purchase
72-UMO-C	With Basic and C software drivers and utilities

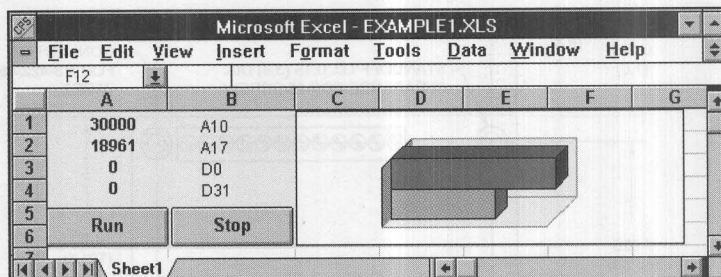
Available from your local authorized Grayhill Distributor.

For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

MICRODAC DYNAMIC DATA EXCHANGE (DDE) SERVER

FEATURES

- Microsoft Windows 3.1 Based
- Share data between MicroDACs and Windows Applications
- Wonderware In Touch Compatible
- Microsoft Excel Compatible



GENERAL DESCRIPTION

The MicroDAC Server is a Microsoft Windows application program that gives other Windows application programs access to the MicroDAC network. The status of analog or digital I/O points on the network can be read by the DDE Server and passed directly into Windows application programs. Likewise, the output of analog or digital I/O can be altered using the DDE Server. Typical Windows application programs which utilize the DDE Server include Wonderware In Touch, Iconics WinWorks, Labtech Vision, Canary Labs Trendlink, Microsoft Excel, Lotus 1-2-3, and Visual Basic.

Once the configuration is complete, to read values into specific cells in an Excel spreadsheet, move the cursor to that cell and type the formula:

=MD_DDE!<TOPIC NAME>!<ITEM NAME>

Writing from Excel to the MicroDAC DDE Server is accomplished by creating a macro sheet following the guidelines in the Users Manual.

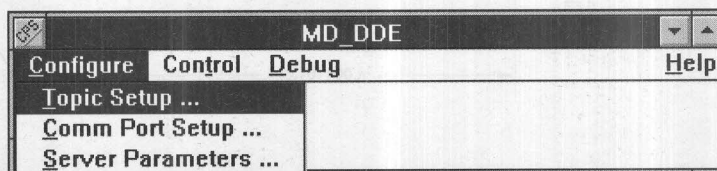


Figure 1

The DDE Server has an embedded MicroDAC driver which handles coding and decoding of the serial messages sent to the MicroDACs. The DDE Server translates the messages into the DDE protocol which identifies an element of data by using a three part address consisting of an "Application", "Topic" and "Item". The MicroDAC DDE Server follows this convention and provides convenient Windows based screens for configuring and storing the Applications, Topics, and Items (Figure 1). A "point and click" screen is also used to set up the I/O module locations (Figure 2).

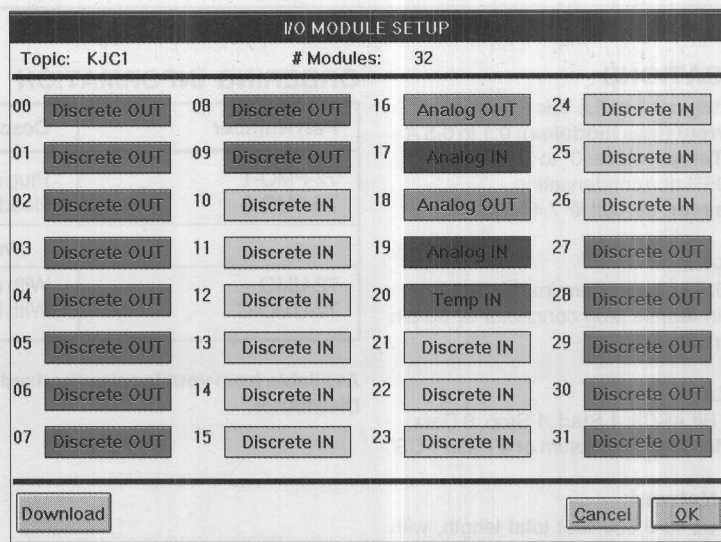


Figure 2

ORDERING INFORMATION

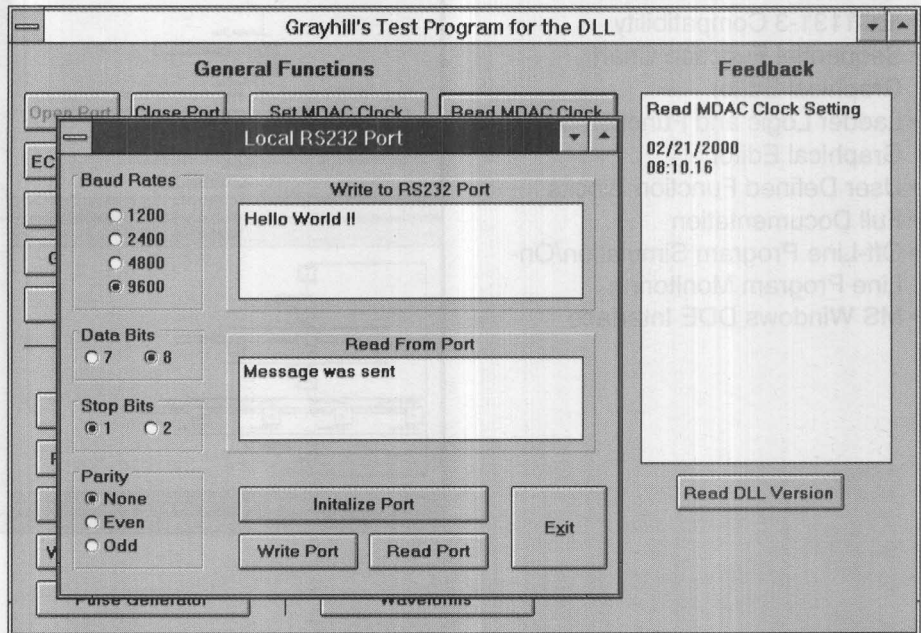
Part Number	Description
72-UMM-DDE	DDE User's manual and software

Available from your local Grayhill Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

MICRODAC DYNAMIC LINK LIBRARY (DLL)

FEATURES

- Microsoft¹ Windows 3.1 Compatible Library
- Link Visual Basic, Visual C/C++, and Borland² Applications to MicroDAC
- Build Custom MMIs



GENERAL DESCRIPTION

The MicroDAC Dynamic Link Library (DLL) is a Microsoft Windows™ 3.1 compatible library which gives other Windows application programs access to a MicroDAC controller. The DLL gives the user the ability to write application programs in the Windows environment and create a link to the network of MicroDAC controllers. The DLL func-

tions are called up by application programs to carry out specific actions on the MicroDAC controller. The DLL can be called and used by any number of programs concurrently. The DLL is intended for users who are programming in Visual Basic 3.0, Visual C/C++ 1.0, or Borland 4.5 compilers.

The DLL is used by calling functions and passing specific item types to the functions. The DLL function types are used to build, send and receive ASCII strings that control and gather data from the controllers on the network. The User's Manual included with the DLL provides a complete description of each of the function types and item types.

ORDERING INFORMATION

Part Number	Description
72-UMM-DLL	DLL User's manual and software

Available from your local Grayhill Industrial Distributors. For prices and discounts, contact a local Sales Office, an authorized local distributor, or Grayhill.

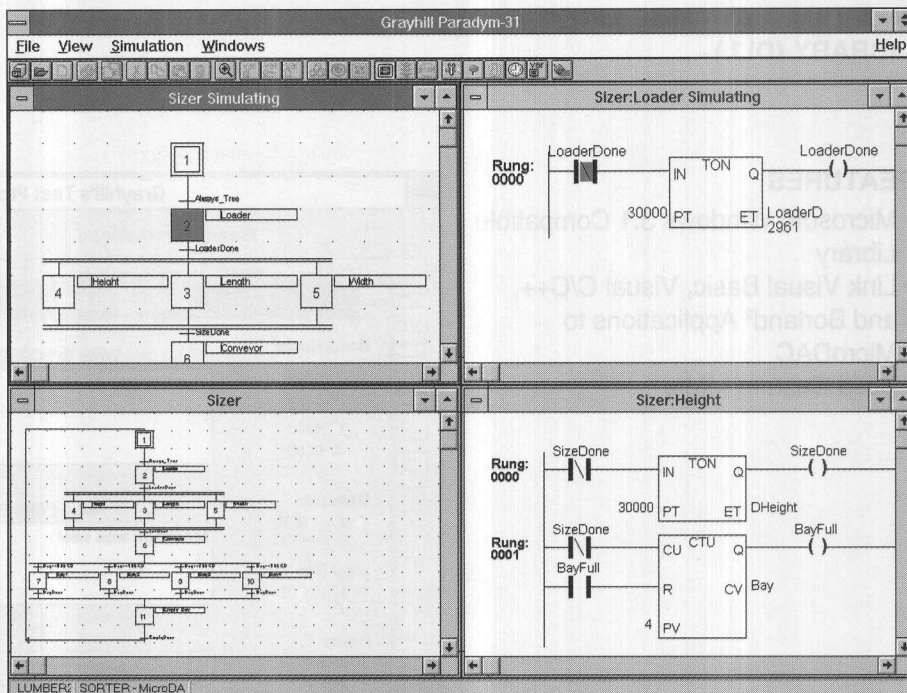
¹ Microsoft is a trademark of Microsoft Corp.

² Borland is a trademark of Borland International Inc.

PARADYM-31 SOFTWARE FOR PROGRAMMING MICRODAC

FEATURES

- Microsoft Windows Based
- IEC1131-3 Compatibility
- Sequential Function Chart Graphical Editor
- Ladder Logic and Function Block Graphical Editor
- User Defined Function Blocks
- Full Documentation
- Off-Line Program Simulation/On-Line Program Monitoring
- MS Windows DDE Interface

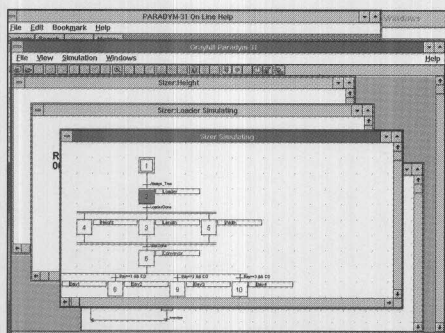


GENERAL DESCRIPTION

Paradym-31 is an IEC1131-3 MS Windows based graphical programming environment which allows you to create, debug, and manage real-time data acquisition and control programs written in traditional programmable controller languages. It contains a highly integrated collection of programming tools for building data acquisition and control programs which run on Grayhill MicroDACs.

MS WINDOWS BASED

Paradym-31 is a Microsoft Windows based application. The Graphical User Interface (GUI) is designed to look, act, and feel like other Windows products with familiar pull-down menus, dialog boxes, icons, and other object-oriented graphics. This makes MicroDAC programming easy-to-learn and easy-to-use.



IEC1131-3 COMPATIBILITY

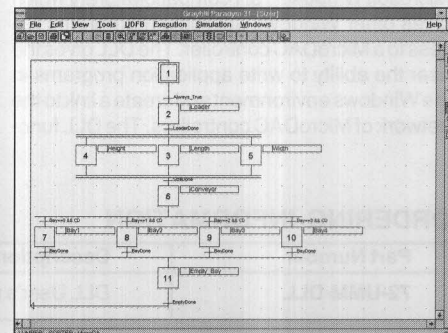
The Paradym-31 languages, their functionality, and the program execution environment are based on the IEC1131-3 Programmable Controller Language Specification. This specification was ratified on the earlier GRAFCET and IEC 65A standards.

SEQUENTIAL FUNCTION CHART (SFC) GRAPHICAL EDITOR

The SFC divides the process cycle into a number of well-defined steps, which are separated by transitions. It is the flow chart or road map of how and when your ladder diagram programs will execute. The SFC is invaluable during all phases of the system development. In the concept phase, it helps to organize thoughts before actual programming is done. During installation, the SFC greatly improves the communication between the system architect, project manager, and systems integrator. Perhaps the SFC's greatest benefit is during start up and fine tuning, when problems can be isolated quickly to small sections of the program.

The basic elements of the SFC are **actions**, **steps** and **transitions**. An action is a piece of program that is carried out while a step is active. A step consists of any number of actions which are carried out until the condition specified in the transition is met. Transitions describe the condition

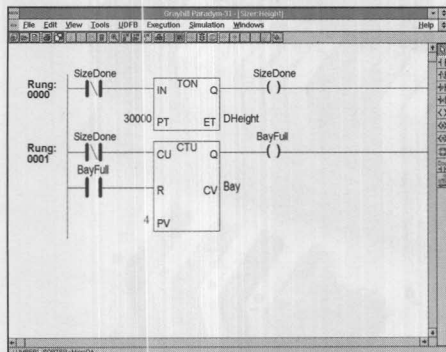
that will cause the chart to move from the step preceding it to the step following it. The language supports steps being sequenced in series or parallel.



LADDER LOGIC AND FUNCTION BLOCK GRAPHICAL EDITOR

The Ladder Logic and Function Block language is used to program each of the actions shown in the SFC. It has a powerful collection of symbols that can be combined into complex control and/or data acquisition programs. The traditional contact and coil symbols which represent inputs and outputs are enhanced by a rich set of function blocks which include timer and counters, arithmetic, data transfer, PID control algorithms,

scan time counters, interface to local displays and keyboards, time stamp and storage of analog data.

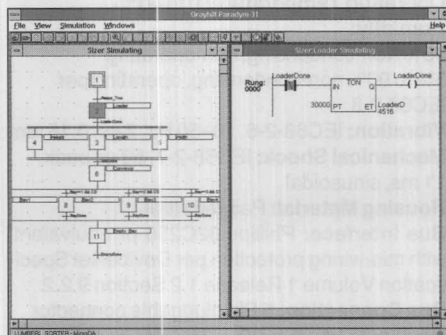


USER DEFINED FUNCTION BLOCKS

UDFBs allow you to create your own function blocks to perform tasks specific to your application. The internal logic for the function block is written in C language. Once complete, the UDFB can be placed into the Ladder Logic Diagram just like any other function block.

OFF-LINE PROGRAM SIMULATION

Before downloading the program to target MicroDAC(s), you can simulate and test the program using the **simulation** function. With this tool, you can run Sequential Function Chart and Ladder Logic programs in the computer and see how they will operate. You can change the state of variables or data values and then sequence through one scan, several scans, or continuously scan to see the effect. Using simulation, the program logic is much easier to debug than during actual machine operation.

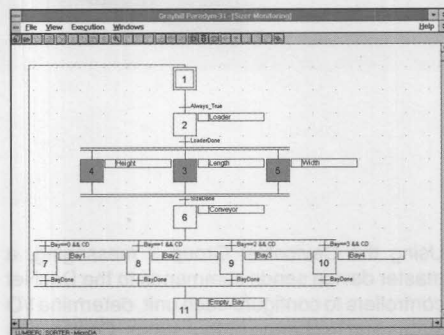
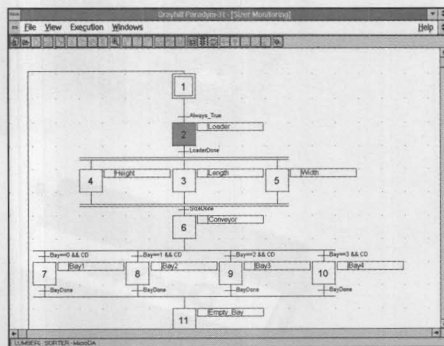


PROGRAM DOWNLOADING AND INITIATING

Once the program is complete, the building block icon is selected. Dialog boxes appear on screen which show the program being compiled and downloaded to the target MicroDAC over RS-422/485 network. The Paradym-31 program can be started or stopped via command from the host computer or automatically every time power is cycled to the MicroDAC.

ON-LINE MONITORING

Paradym-31 can monitor the execution of your program running on the MicroDAC in real-time. Counter presets, variables, and flags can be changed dynamically through dialog boxes via the monitoring function. Communications between Paradym-31 and the MicroDAC take place over the RS-422/485 serial link.



DDE SERVER

A built-in Dynamic Data Exchange (DDE) server allows standard Windows DDE clients (Excel, Visual Basic, Wonderware, etc.) easy access to MicroDAC I/O data and Paradym-31 variables over the network. This greatly simplifies the task of reading and writing process information between a MicroDAC and an operator interface package running on a host PC.

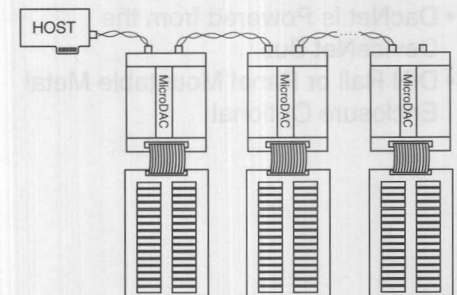
FULL DOCUMENTATION

Like most advanced programming tools, Paradym-31 features a self documentation capability that can automatically generate documentation for the project's most current Sequential Function Charts, Function Block

diagrams, or Ladder Diagrams. In addition, the built-in cross reference can prove extremely useful for debugging and troubleshooting. This feature generates a cross reference of selected variables either in on-line interactive mode or off-line via prompt.

TYPICAL SYSTEMS CONFIGURATION

The adjacent figure shows a typical MicroDAC system configuration. Each MicroDAC node can be running the same or different Paradym-31 programs to control or monitor their local I/O. The PC host typically has supervisory responsibility and acts as the Man-Machine-Interface. By issuing Optomux commands, the host can scan each of the MicroDAC nodes and obtain the current status of inputs, retrieve time stamped data collected by MicroDAC, or force the states of inputs.



TARGET CONTROLLERS

The following Grayhill MicroDACs will accept Paradym-31 programs:

Part Number	Description
72-MDC-32ADP	Analog or digital I/O with 128K battery backed RAM, auxiliary RS-232 port, real-time clock, and aluminum housing.
72-MDL-32ADP	Analog or digital I/O with 128K RAM
72-MDLE-32ADP	Analog or digital I/O with 128K RAM and metal enclosure

MINIMUM COMPUTER REQUIREMENTS

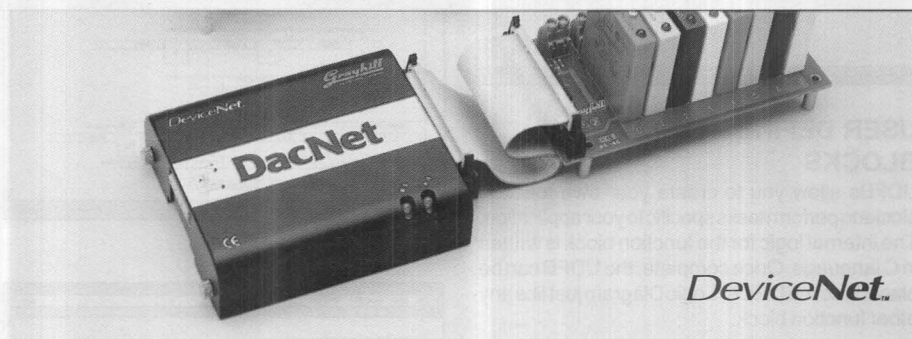
IBM PC or compatible with 4 MB RAM, 20 MB hard disk. VGA, mouse or trackball, Windows 3.1 and DOS, and 1 RS-432 or RS-422/485 port.

ORDERING INFORMATION

Part Number	Description
72-UMM-P	Paradym-31 User's manual, software, Borland compiler examples, and key with full editing, development, and downloading capability.
72-UMM-PL	Paradym-31 monitor package permits downloading of programs, changing of constants, and monitoring of the program execution. Ideal for shipment with equipment in OEM applications.

Available from your local Industrial Distributor only.

- CE Compliant (with optional enclosure) EN50082-2* and CISPR11 Limit A
- Communications Over DeviceNet at 125K, 250K, or 500K baud
- DeviceNet Group 2 Only Slave
- DacNet is Powered from the DeviceNet Bus
- DIN Rail or Panel Mountable Metal Enclosure Optional



GENERAL DESCRIPTION

The DacNet controller interfaces Grayhill analog and digital single point I/O modules with DeviceNet—a low cost communications bus for industrial devices such as limit switches, photoelectric switches, valves, motor starters, operator interfaces, PLCs, and PCs. The DeviceNet bus is based on a broadcast-oriented, open communications protocol—the Controller Area Network (CAN).

By installing a distributed control system using the DacNet controller, you eliminate the long sensor lines. The DacNet controller is designed to be placed near the actual sensors and actuators; shortening the sensor lines to minimal distances. These controllers are networked back to a DeviceNet master via a network cable. Depending on the network configuration, you may have up to 62 DacNet controllers on a DeviceNet network with a total network distance of 500 meters. Each DacNet is connected to an I/O module mounting rack. The racks are available in 8, 16, 24, or 32 I/O positions. Analog or digital modules, input or output, in any combination, can be plugged into each location on the rack. The maximum number of I/O that can be serviced by a DacNet network is 1984 (62 controllers x 32 I/O).

Using the DeviceNet Group 2 messaging, a master device sends commands to the DacNet controllers to configure each unit, determine I/O status and to change output status. Commands are transmitted over the DeviceNet at baud rates up to 500 Kbaud. The command and response messages are 100% compatible with DeviceNet Group 2 messaging protocol.

DacNet contains the necessary circuitry for monitoring 5V digital signals or frequency measurement (Grayhill analog input modules convert the analog inputs to frequencies) on each of its 32 I/O lines. DIP switches set the DeviceNet MAC ID and baud rate. On power up the microprocessor runs a diagnostic self test. After successful completion of the self test, the DIP switches are read, and the peripherals are initialized. Following initialization, a hardware interrupt occurs every 1 millisecond. Each time the interrupt occurs, the CPU instructs the I/O controller to read and store the digital module status, update digital outputs, read 1 analog input, and write up to 2 analog output points. When a DeviceNet master requests I/O status from DacNet, the data is retrieved from RAM and placed in the response buffer.

SPECIFICATIONS

Microprocessor: NEC V25+

Source: Supplied by DeviceNet, non-isolated

Supply Voltage: 11–25 Vdc; 24 Vdc nominal

Supply Current:

DeviceNet power supply @ 25 Vdc, controller only, 160 mA

DeviceNet power supply @ 11 Vdc, controller only, 240 mA

Operating Temperature: 0 to 60°C

Humidity:

95% Non-condensing, non-operating

5% to 90% non-condensing, operating per IEC68-2-3

Vibration: IEC68-2-6, 10–50 Hz, 2 gs, 0.15 mm

Mechanical Shock: IEC68-2-7, 50 gs peak, 11 ms, sinusoidal

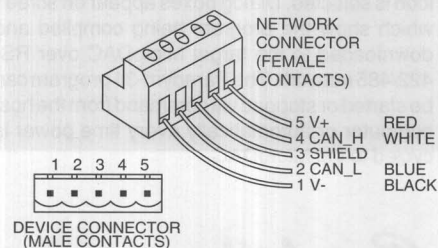
Housing Material: Painted steel

Bus Interface: Phillips 82C250 or equivalent, with mis-wiring protection per DeviceNet Specification Volume 1 Release 1.2 Section 9.2.2

Bus Connection: 5 Pin pluggable connector

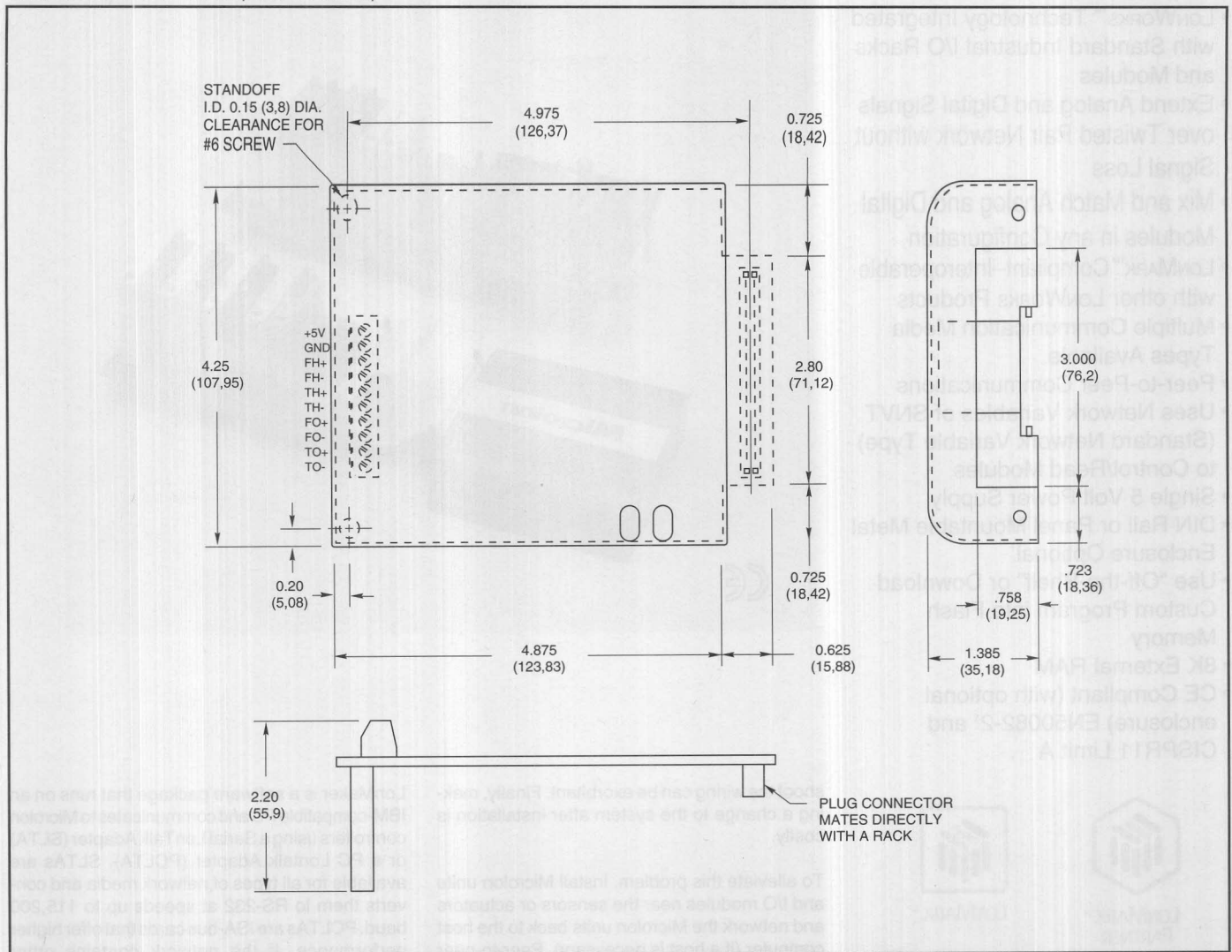
Device Type: 0 x 00_{hex}—DacNet is a Generic Device

Device Profile: Conforms with the DeviceNet Standard Volume 1 Release 1.3 and Volume ii Release 1.2



*72-DNTE-32AD only.

DIMENSIONS In inches (and millimeters)



ORDERING INFORMATION

Part Number	Description
72-DNT-32AD	DacNet without enclosure
72-DNTE-32AD	DacNet with enclosure
72-DNT-I	DacNet User's Manual

Available from your local authorized Grayhill Distributor. For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

FEATURES

- LONWORKS™ Technology Integrated with Standard Industrial I/O Racks and Modules
- Extend Analog and Digital Signals over Twisted Pair Network without Signal Loss
- Mix and Match Analog and Digital Modules in any Configuration
- LONMARK™ Compliant—Interoperable with other LONWORKS Products
- Multiple Communication Media Types Available
- Peer-to-Peer Communications
- Uses Network Variables of SNVT (Standard Network Variable Type) to Control/Read Modules
- Single 5 Volt Power Supply
- DIN Rail or Panel Mountable Metal Enclosure Optional
- Use "Off-the-Shelf" or Download Custom Program into Flash Memory
- 8K External RAM
- CE Compliant (with optional enclosure) EN50082-2¹ and CISPR11 Limit A



LONMARK™
PARTNER

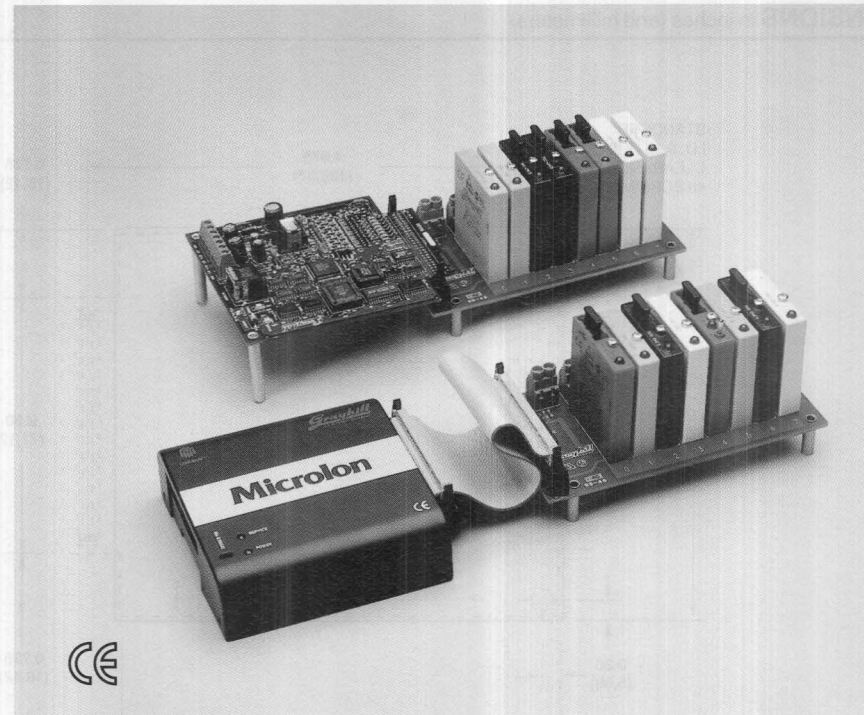


LONMARK™

GENERAL DESCRIPTION

The Microlon controller combines the power of LONWORKS technology with Grayhill standard industrial I/O racks and modules. Microlon controllers may be distributed over great distances yet provide seamless interoperability. The robust communication protocol LonTalk® is built into the firmware of the Neuron® chip, the heart of LONWORKS™ technology. The LonTalk protocol follows the (7 layer) OSI Reference Model for network protocols. This technology is becoming the de facto standard for interoperability. This frees the user from worrying about network communication protocols.

In applications where the inputs and outputs that need to be monitored and controlled are spread out over a large area, running long signal lines from the sensors and actuators to a central controller can lead to numerous costly problems. First, there is the time and expense of routing the signal lines and shielding them from cross-talk, EMI, and RFI. If this is not done properly, the cost and time required to trouble-



shoot the wiring can be exorbitant. Finally, making a change to the system after installation is costly.

To alleviate this problem, install Microlon units and I/O modules near the sensors or actuators and network the Microlon units back to the host computer (if a host is necessary). Peer-to-peer communications, inherent with LONWORKS technology, make it easy to extend signals digitally, without signal loss.

Up to 63 Microlon controllers (nodes) can be networked together on a physical segment. Units can be added with the aid of repeaters or routers. Each node may contain up to 8 isolated modules, configured as input or output, digital or analog.

Microlon controllers use one of three different physical media types to communicate over the network. Twisted pair, transformer isolated (TP/XF) networks operate at 78 Kbps or 1.25 Mbps at distances up to 6500 feet (2000 meters) and 1600 feet (500 meters) respectively. In addition, FTT-10 operating at 78 Kbps at distances up to 1500 feet (500 meters) is supported. Routers and Bridges may be used to change the communication media type from node to node. For example, a Router may connect a group of nodes operating over the FTT-10 medium to another group utilizing the TPT-XF/1250 medium.

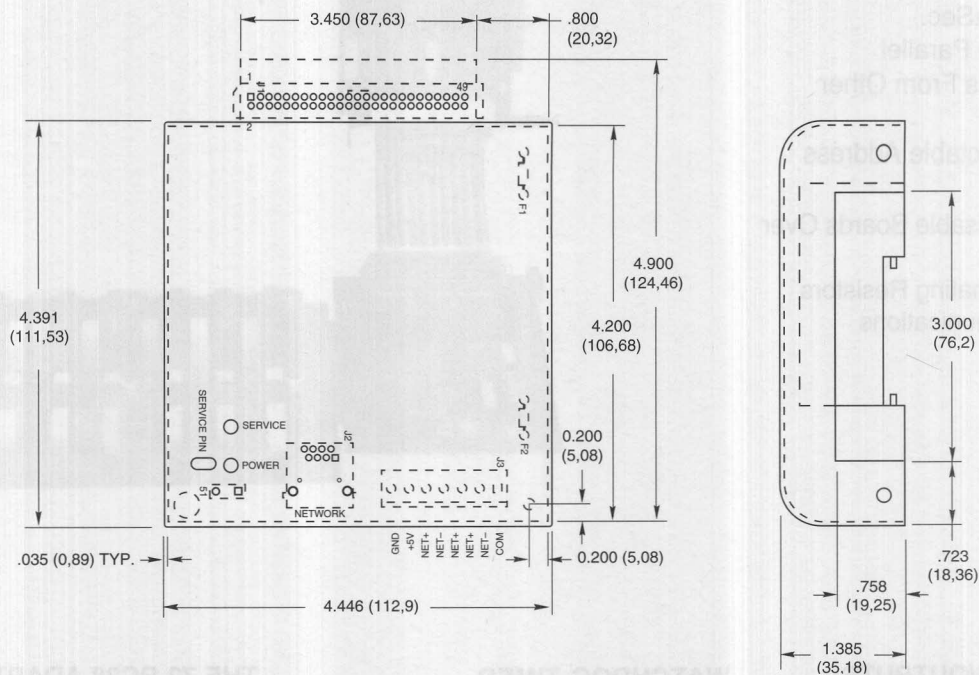
Networks are installed and/or modified using the Echelon® LonBuilder® Development system, LonMaker™ installation tool or a third party tool.

LonMaker is a software package that runs on an IBM-compatible PC and communicates to Microlon controllers using a Serial LonTalk Adapter (SLTA) or a PC Lontalk Adapter (PCLTA). SLTAs are available for all types of network media and converts them to RS-232 at speeds up to 115,200 baud. PCLTAs are ISA-bus cards that offer higher performance. If the network contains other LONWORKS based products, the NetProfiler™ (included with LonMaker) is used to define the "parts catalogs" tailored to the network. Otherwise, for networks containing only Microlon controllers, the "parts catalog" will be provided, eliminating the need for the NetProfiler package. Third party network management, control and monitoring tools and LonTalk Adapters are available, please contact Grayhill for more information.

The Microlon controller is shipped with a standard application program which contains everything necessary to interface with all of Grayhill's I/O modules. Installation, Configuration, and Troubleshooting are outlined in the 72-LON-I8 manual (order separately). In addition, the Microlon application disk is supplied with the manual and contains example source code and the interface files ("parts catalog"). The *readme* file contains information not found in this manual. If you have a LonBuilder or NodeBuilder™ Development Tool, you may wish to modify the application program and tailor it to your application.

¹ With metal enclosure installed
Echelon, LonBuilder, Neuron, LonTalk and 3150 are U.S. registered trademarks of Echelon Corporation. LONWORKS, LonMaker, NodeBuilder and NetProfiler are trademarks of Echelon Corporation.

DIMENSIONS In inches (and millimeters)



UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE ± 0.010 (0,25).

SPECIFICATIONS

Microprocessor: Neuron 3150®
Clock Speed: 10 MHz
Power Supply: 4.75 Vdc to 5.25 Vdc
Supply Current: 200 mA max. (controller only), 110 mA typical
Operating Temperature: 0°C to 70°C
Humidity:
 95% non-condensing, non-operating
 5% to 90% non-condensing, operating per IEC68-2-3
Vibration: IEC68-2-6, 10–50 Hz, 2 gs, 0.15 mm
Mechanical Shock: IEC68-2-7, 50 gs peak, 11 ms, sinusoidal
Housing Material: Painted steel
Connections:
 Bus: RJ-45 or terminal block
 Rack: 50 Pin female plug connector or 50 pin male header connector

ORDERING INFORMATION

Part Number	Description
Panel Mount (Standoffs—plugs directly into I/O rack)	
72-LON-8AD-78P	TPT-XF/78 78 Kbps transformer isolated*, up to 2000 meters
72-LON-8AD-12P	TPT/XF-1250 1.25 Mbps transformer isolated*, up to 500 meters
72-LON-8AD-FTTP	FTT-10 78 Kbps transformer isolated*, up to 500 meters
Panel or DIN Rail Mount (Metal enclosure)	
72-LON-8AD-78C	TPT-XF/78 78 Kbps transformer isolated, up to 2000 meters
72-LON-8AD-12C	TP/XF-1250 1.25 Mbps transformer isolated, up to 500 meters
72-LON-8AD-FTTC	FTT-10 78 Kbps transformer isolated*, up to 500 meters
Manual and Software	
72-LON8	Introduction to Microlon® Controller
72-LON-I8	Installation, Configuration, and Troubleshooting Manual with example source files, interface (.XIF) files, and parts catalog

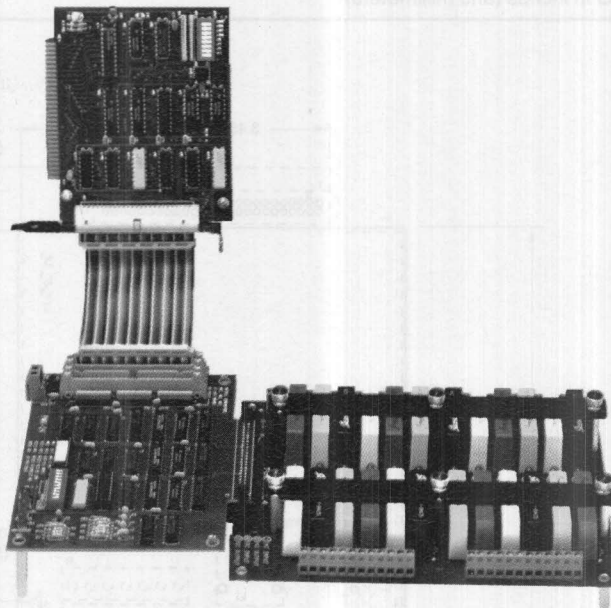
* Isolation between controller and network 1000 Vrms for 60 seconds; 277 Vrms continuous.
 Isolation between controller and I/O is 4000V for digital; 2500V for analog.

Available from your local authorized Grayhill Distributor.

For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

FEATURES

- Each Board Controls 24 or 32 Digital Modules
- Scans 512 Digital I/O Points in Less Than 200 μ Sec.
- Compatible With Parallel Controller Boards From Other Manufacturers
- DIP Switch Selectable Address and Options
- Up to 32 Addressable Boards Over 500 Feet
- On-Board Terminating Resistors
- On-Board Communications Watchdog Timer



DIGITAL INPUTS/OUTPUTS

The 72-PMX-24D controller board mates with any of our 8, 16, or 24 digital module racks. The 72-PMX-32D controller board mates with special rack part number 70GRCP32-HL which accepts up to 32 G5 digital I/O modules. Connections are made between the IBM PC¹ (or other type of host) parallel port and the controller boards via a 50 pin flat ribbon cable. The cable can be up to 500 feet in length. The cable from the host is connected to the first controller board on the bus and then daisy chained to additional controller boards. Up to 32 controller boards with 16 module racks (or 16 controller boards with 24 or 32 module racks) can be added anywhere along the cable. The maximum number of I/O per parallel port is 512.

SPEED

The parallel bus is high speed. The host computer can read or write eight digital I/O modules in less than 3 microseconds which means that 512 digital I/O modules can be scanned in less than 200 microseconds! Each group of eight I/O modules are accessed through a separate I/O port register on the host computer or controller. In assembly language, an **IN** or **OUT** instruction is used to read or write this information. In C language, an **inp** or **outp** function call is used. In BASIC, an **INP** or **OUTP** instruction is used.

WATCHDOG TIMER

Each controller board has an on-board communications watchdog timer which monitors communications between the host and controller board. A timer value between 0.5 seconds and 12 seconds is selected for each board. On power up, the timer begins counting down. Whenever a message from the host is received, the timer is restarted. Should the timer time out, all of the output modules being controlled by the board will be set to a predetermined state (ie. all off).

OTHER FEATURES

One of the control lines on the parallel bus is called RESET. The RESET line can be used to simultaneously turn off all of the output modules being controlled by each of the boards on the bus.

Three LEDs on the controller boards assist in troubleshooting problems. They indicate when power is being applied, when messages are being received, and when the watchdog timer has timed out.

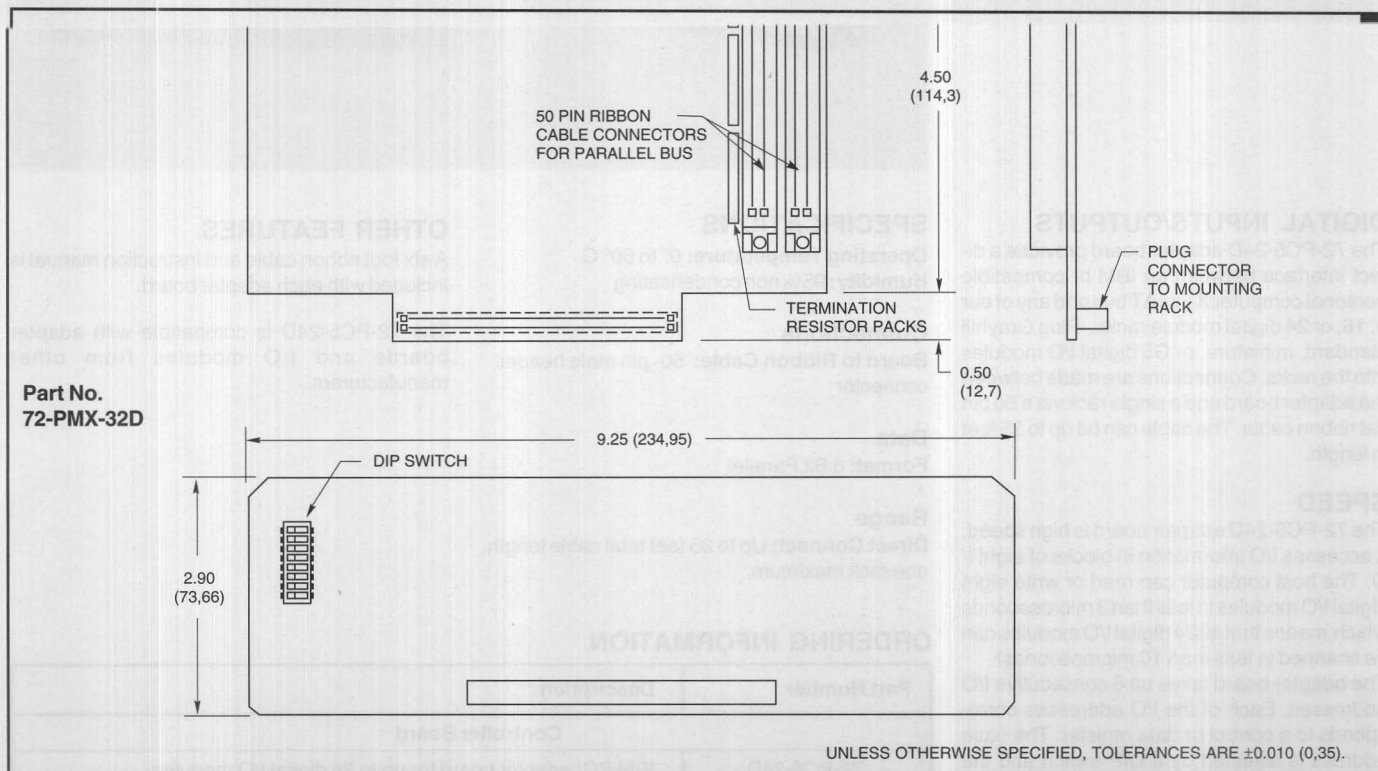
THE 72-PC28 ADAPTER CARD

In applications where the host computer is an IBM PC¹ or compatible, the 72-PC28 adapter card is an IBM PC/XT/AT bus to parallel bus interface which occupies a single half slot in the computer. The bus ribbon cable plugs into its 50 pin male header connector. Each adapter card can drive up to thirty two 72-PMX-24D controller boards or sixteen 72-PMX-32D controller boards over a total distance of 500 feet. Up to four 72-PC28 adapter cards can be installed in one IBM PC¹. The base address for the card and wait states are DIP switch selectable.

Each 72-PC28 includes a complete User's Manual and a software setup/test utility program. This program graphically (EGA or VGA required) shows you dip switch, jumper and termination resistor settings for the system configuration you decided. You can then use the program to configure and manipulate any I/O on the parallel bus.

All controller boards are thoroughly tested prior to shipment.

¹ IBM PC is a trademark of IBM Corp.



SPECIFICATIONS

Supply Voltage: 4.9 to 5.1 Vdc

Supply Current (board only): 1.5 A maximum

Operating Temperature: 0° to 60° C

Humidity: 95% non condensating

Connections (72-PMX-24D)

Parallel bus: Two 50-pin male header connectors

Rack: 50-pin female plug connector

Connections (72-PMX-32D)

Parallel bus: Two 50-pin male header connectors located on rack 70GRCP32-HL

Rack: 70-pin female plug connector

Data

Format: 8 Bit Parallel

Range

Multidrop: Up to 500 feet total cable length, with (32) 72-PMX-24D or (16) 72-PMX-32D boards maximum

ORDERING INFORMATION

Part Number	Description
Controller Board	
72-PMX-24D	Parallel controller board for up to 24 digital I/O modules
72-PMX-32D	Parallel controller board for 32 G5 digital I/O modules
Adapter Card	
72-PC28	IBM PC parallel port plug-in board, includes 72-UMP manual
User's Manual	
72-UMP	Manual with utility software and sample programs
For finished ribbon cable assemblies, see "Controller Accessories"	

Available from your local authorized Grayhill Distributor.

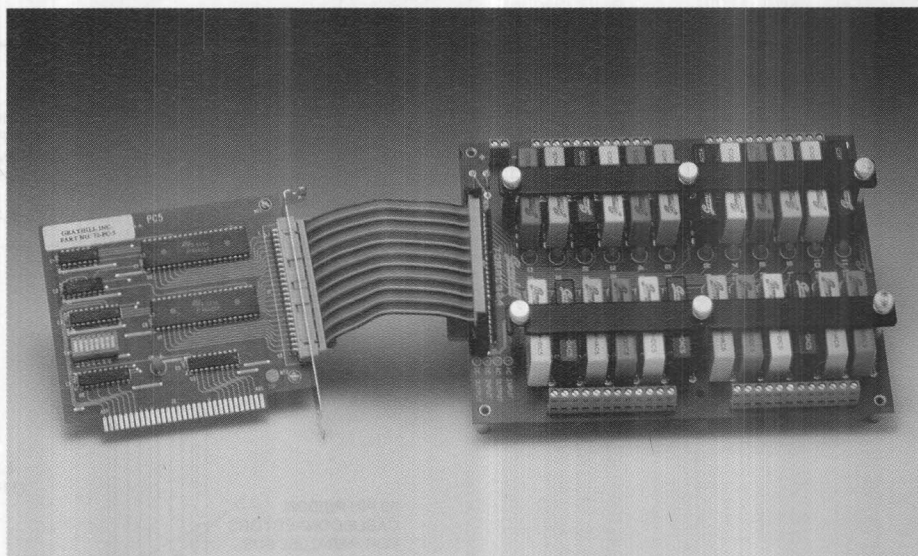
For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.



ISA BUS ADAPTER BOARD

FEATURES

- Each Board Controls Up to 24 Standard, Mini or G5 Digital Modules
- 6 Foot Ribbon Cable Included
- DIP Switch Selectable Address
- IBM PC¹ XT or AT bus, half slot



DIGITAL INPUTS/OUTPUTS

The 72-PC5-24D adapter board provides a direct interface between an IBM or compatible personal computer XT or AT bus and any of our 8, 16, or 24 digital module racks. Plug Grayhill standard, miniature, or G5 digital I/O modules into the racks. Connections are made between the adapter board and a single rack via a 50 pin flat ribbon cable. The cable can be up to 25 feet in length.

SPEED

The 72-PC5-24D adapter board is high speed. It accesses I/O information in blocks of eight I/O. The host computer can read or write eight digital I/O modules in less than 3 microseconds which means that all 24 digital I/O modules can be scanned in less than 10 microseconds! The adapter board takes up 6 consecutive I/O addresses. Each of the I/O addresses corresponds to a control or data register. The base address is selected by a DIP switch and the other five are automatically assigned.

Each group of eight I/O modules are accessed through a separate I/O address on the host computer. In assembly language, an **IN** or **OUT** instruction is used to read or write this information. In C language, an **inp** or **outp** function call is used. In BASIC, an **INP** or **OUTP** instruction is used.

SPECIFICATIONS

Operating Temperature: 0° to 60° C

Humidity: 95% non condensating

Connections

Board to Ribbon Cable: 50- pin male header connector

Data

Format: 8 Bit Parallel

Range

Direct Connect: Up to 25 feet total cable length, one rack maximum.

OTHER FEATURES

A six foot ribbon cable and instruction manual is included with each adapter board.

The 72-PC5-24D is compatible with adapter boards and I/O modules from other manufacturers.

ORDERING INFORMATION

Part Number	Description
Controller Board	
72-PC5-24D	IBM PC ¹ adapter board for up to 24 digital I/O modules.
User's Manual	
Included with adapter board.	
For finished ribbon cable assemblies, see "Controller Accessories"	

Available from your local Authorized Grayhill Distributor. For prices and discounts, contact your local sales office, an authorized Distributor, or Grayhill.

72-CNV-10, 72-CNV-11 and 72-CNV-12

FEATURES

- On-Board Power Supply
- Jumper Selectable 110/220 VAC Operation
- Optical Isolation Between RS-232 and RS422/485
- DIP Switch Selectable DTE/DCE Setting
- Multiple Mounting and Connector Options
- Bi-directional CTS and RTS Handshaking Lines
- Baud Rates to 115.2 Kb
- Transient Protection on the RS-422/485 Lines
- LED Indicators for TX, RX, CTS, RTS and Power

GENERAL DESCRIPTION

The 72-CNV-XX family of converters offer a flexible and reliable solution to the challenge of interfacing devices conforming to different serial communication standards. The converters allow an RS-232 device (ie. PCs, PLCs, Embedded Controllers) to communicate reliably over long distances to multiple devices utilizing the RS-422/485 standard. Reliability is an inherent benefit of the differential mode communication of RS-422/485. Noise introduced onto the RS422/485 link affects both the positive and negative side equally, preserving the integrity of the differential signal between them. Long distances and multiple slave devices are supported by the converters. In half-duplex (2-wire) RS-485 mode, handshaking can be controlled from either end of the communication link. Typical applications involve connecting a host computer to remotely located serial devices such as

printers, control equipment, or data acquisition devices distributed throughout an office or factory.

The multiple mounting and connector options allow for many installation possibilities. All three versions conform to a Eurocard 3U size (160 mm x 100 mm). 72-CNV-10 will mount in a DIN 41494 card cage. AC power and the RS-422 signals are brought out to a DIN standard 41612 15-pin connector (Harting p/n 09061152911 or equivalent). 72-CNV-11 has standoffs to facilitate panel mounting. AC power comes in to a screw-type terminal strip. RS-422 signals are on a separate terminal strip or a female DB-9 connector. 72-CNV-12 has

a DIN rail card carrier which permits the assembly to snap on a DIN rail. AC power and RS-422 signals are brought in to two screw-type terminal strips. A female DB-25 connector transfers the RS-232 signals for all three versions.

SPECIFICATIONS

Supply Voltage Range (V_{ps}): 110/220 Vac (jumper selectable)

Maximum Supply Current (I_{ps}): 120 mA

Isolation Voltage: 4000 Vac

Transmission Rate: 300 to 115,200 Baud

Operating Temperature Range: 0 to 60°C

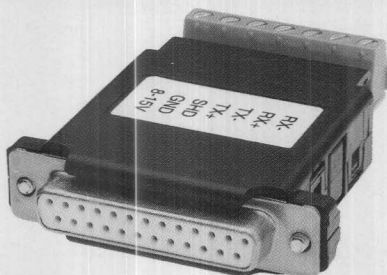
95% relative humidity, non-condensing

Indicators: TX, RX, CTS, RTS and Power

ORDERING INFORMATION

Part Number	Description
72-CNV-10	RS-232 to RS-422/485 converter for DIN card cage (Pictured)
72-CNV-11	RS-232 to RS-422 converter for panel mount
72-CNV-12	RS-232 to RS-422/485 converter for DIN rail mounting

72-CNV-2, 72-CNV-4 and 72-CNV-5



72-CNV-4 and 72-CNV-5 convert serial communications from RS-232 to RS-485 in both directions. The converter simply plugs into any male RS-232 DB-25 connector and converts the transmit and receive signals to RS-485 (RS-422) levels at speeds to 115.2 Kb. The converters are configured for DTE (default) or DCE operation.

The 72-CNV-2 is similar to the 72-CNV-4 except that it provides optical isolation and operates only in an RS-422 mode at a maximum rate of 19.2 Kb.

Supply Voltage:

+8 to +15 Vdc (-2 and -4 versions)

+5Vdc (-5 version)

Supply Current:

62 mA plus output load (-2 version)

30 mA plus output load (-4 and -5 version)

Operating Temperature Range: 0-60°C

ORDERING INFORMATION

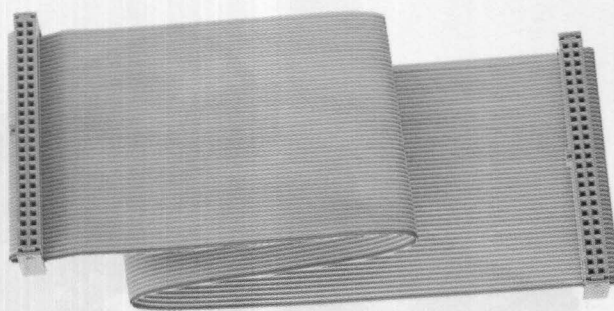
Part Number	Description
72-CNV-2	RS-232 to RS-422 converter with optical isolation
72-CNV-4	RS-232 to RS-422/485 converter with 8 to 15V operation
72-CNV-5	RS-232 to RS-422/485 converter with 5V operation

Available from your local Grayhill Distributor

For prices and discounts, contact a local Sales Office, an authorized Distributor, or Grayhill.

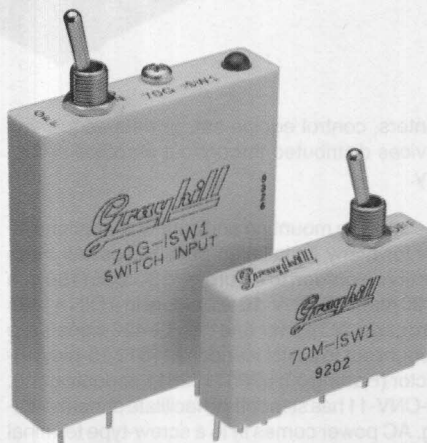
CONTROLLER ACCESSORIES

CABLE ASSEMBLIES



Several standard cable assemblies to connect controllers to our I/O module mounting racks may be ordered. The 72-CHH cable has a 50-pin header connector on each end to mate with those on mounting racks. The 72-CHE cable has a 50-pin header connector on one end and a 50-pin edge card connector on the other.

TEST MODULES



Modules for use in system set up and testing may be ordered. Modules 70M-ISW1 and 70G-ISW1 simulates an input; 70M-OSW1 switch simulates an output.

ORDERING INFORMATION

Part Number	Description
72-CHH-A	Ribbon cable assembly, header to header, 6 inches long
72-CHH-1	Ribbon cable assembly, header to header, 1 foot long
72-CHH-2	Ribbon cable assembly, header to header, 2 feet long
72-CHH-4	Ribbon cable assembly, header to header, 4 feet long
72-CHH-6	Ribbon cable assembly, header to header, 6 feet long
72-CHE-2	Ribbon cable assembly, header to edge card, 2 feet long
72-CHE-4	Ribbon cable assembly, header to edge card, 4 feet long
72-CHE-6	Ribbon cable assembly, header to edge card, 6 feet long
70G-ISW1	Input module test switch, G5 package
70M-ISW1	Input module test switch, Mini package
70M-OSW1	Output module test switch, 3 amp, Mini package

Controller Boards, I/O Modules, Module Racks, and Accessories are available through Authorized Grayhill Industrial Distributors. For prices and discounts, contact your local sales office, an authorized Industrial Distributor, or Grayhill.

A

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10	D-25;		Pushbutton Switches
12	F-40;	-58	Rotary Accessories
19	F-24		Rotary Switches
22	G-6		Sockets
23	D-24;	-33	Pushbutton Switches
24	F-26		Rotary Switches
25	E-15 to -16		Encoders
26	E-17		Rotary Switches
29	G-4		Binding Posts
30	D-15 to -18;	-26 to -30, -33 to -34	Pushbutton Switches
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59	F-59 to -62		Rotary Switches
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70	H-5 to -14, I-7 to -17, -27 to -44		Relays and I/O Modules
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73	I-18 to -22		Analog I/O Modules
75	F-13 to -14		Rotary Switches
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78	B-10 to -11, -13, -15 to -19;	-24	DIP Switches
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*Secondary references listed after semicolon are special styles or accessories.

